GETTING A HANDLE ON CHILDREN'S DRAWINGS: A COGNITIVE APPROACH

by

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ABSTRACT

Many researchers of children's drawings have concentrated on assessing how drawing develops through several stages. Around eight years of age the child progresses from producing drawings based on internal stereotypes of objects (intellectually realistic stage), to producing drawings which reflect an external view of these objects (visually realistic stage). This research has highlighted numerous variables which affect this developmental sequence and has shown that children as young as four can produce visually realistic drawings under certain circumstances.

The present study firstly conducted a series of cross-sectional experiments to assess two of the variables highlighted by previous research, i.e. instructions and the order of presentation of tasks. Children between four and eight years of age were asked to draw various cup and ball models while these variables were manipulated. By employing the novel procedure of measuring the amount of attention that the children paid towards the drawing models, it was possible to gain insight into underlying cognitive mechanisms. The research showed that intellectual and visual realism can be artificially induced by procedural changes that affect the amount of strategic attention that the child employs in a drawing task. Increased attention is associated with visual realism while reduced attention is associated with intellectual realism. This thesis therefore concludes that there are no distinct stages of development, but instead these are a by-product of strategic attentional processes.

In order to place drawing in a broader cognitive context, a longitudinal study was then conducted which assessed drawing in relation to memory and selective attention. The developmental patterns of performance, strategy use and metacognitive awareness in the drawing task, were similar to those in the memory and selective attention tasks. This

suggested that children have underlying abilities common to these three different cognitive areas. It was concluded that there is a need to assess drawing within the context of general cognitive development.

LIST OF CONTENTS

CHAPTER/ SECTION	TITLE	PAGE

LIST OF TABLES

LIST OF FIGURES

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CHAPTER 1

INTRODUCTION

1.1 HISTORICAL APPROACHES TO THE STUDY OF CHILDREN'S DRAWINGS

Children's drawings have been studied since the 1880's and was one of the first areas of child psychology to become established as a separate field of research (Freeman, 1977). Since then there have been several different approaches to its study. Up until the 1920's researchers were concerned with cataloguing spontaneous drawings and classifying them into developmental sequences. The most significant of these classifications for future research was detailed by Luquet (1913, 1927). He stated that children's drawings were based on an internal mental model and that they were basically realistic in intention. The child is trying to produce a drawing that is recognisable as a realistic representation of the subject matter. This develops through five stages from around eighteen months of age when children's scribbles contain little representational realism, through increasing levels of realism until around eight years of age when children can accurately represent their surroundings and experiences in a visually realistic way.

Another early developmental approach was put forward by Goodenough (1926) and later revised by Harris (1963). They believed that human figure drawings could be used to assess intellectual development. Although widely used at the time, the "draw-a-man" test was later shown to be unreliable and invalid, and subsequently led to a decline in interest in children's drawings.

This decline was additionally attributed to the dominance of Piagetian theory in the 1970's. Although encompassing a diverse range of cognitive-developmental abilities, Piaget's stage theory of development did not view all of these abilities with the same degree of importance. Only certain concepts were seen as providing the crucial foundations for development, e.g. egocentrism and the spatial organisation of objects. Although drawings were considered to be a form of geometrical ability which is part of the child's concept of space, drawings were generally just used as a form of evidence of how children's spatial representation abilities develop. Evaluations of the theory therefore tended to ignore drawings and concentrate on the central concepts.

Piaget did not develop his own theory of the development of children's drawings but instead incorporated Luquet's stages into his own. Piaget believed, like Luquet, that children draw in order to represent their world. Between the ages of two and seven children's representational abilities become increasing symbolic. This is a consequence of what he called the "semiotic function", i.e. the ability to use symbols. This function therefore involves many different activities such as play, imitation, imagery, language and drawing. When Piagetian theory began to dominate the interest of developmental psychologists, the first four of these symbolic activities and the concept of space were widely researched, however very little attention was paid to children's drawings.

As well as these developmental theories, there were other approaches to the study of children's drawings. The clinical-projective approach developed in the 1940's, was based on the view that drawings can be used to assess personality and are expressions of a child's emotional state. Freud's psychoanalytic theory states that drawings are influenced by unconscious desires and fears, and that they provide a harmless opportunity to release these repressed feelings (catharsis). The artistic approach was based on the view that drawings give sensory and perceptual pleasure, and that we draw in order to make graphic representations of our world. Satisfaction is gained through producing pictures that symbolise and express our own interests and experiences.

The final approach highlights the importance of the process of constructing a drawing. The theoretical approaches detailed above do not take these into account and instead concentrate on the finished product. Freeman (1980) provides evidence of how performance in a drawing task is affected by biases and planning difficulties and criticises the other approaches for ignoring these factors. For example, he believes that Piaget underestimated children's abilities by not distinguishing between what the child actually produces and what they are capable of producing given the right circumstances.

Although Freeman's emphasis on drawing procedures is widely acknowledged by researchers, to date his is the most extensive analysis of this concept.

Since Freeman's work there has been a resurgence of interest in the study of children's drawings. However drawings have generally been assessed in isolation of other cognitive abilities and the processes involved in producing a representational drawing. However more recently Thomas & Silk (1990) have acknowledged that an analysis of the drawing strategies used by children can help to understand not only the drawings themselves, but also the child's planning and organisational abilities.

1.2 LUQUET'S THEORY OF CHILDREN'S DRAWINGS

As discussed in Section 1.1, one of the earliest researchers to describe the development of children's drawings was Luquet in 1927. He believed that children between the ages of five and eight produced *intellectually realistic* drawings. When objects are shown to these children and they are asked to draw them, they are unable to inhibit their own knowledge and experience about these objects and cannot, therefore, just draw the parts that they can see from their viewing perspective. Children at this age produce canonical or stereotypical representations of particular objects, for example a cup must be drawn with a handle, and transparencies where for example body parts are drawn within the outline of clothing. They also have a tendency to produce 'separates'. If two objects are placed in front of the child one behind the other, so that the front object either totally obscures the view of the back object (total occlusion) or just partially obscures it (partial occlusion), then these young children have the tendency to draw two discrete objects that are separated, either horizontally or vertically, on the picture plane.

After the age of eight, Luquet believed a child could draw in a *visually realistic* way by inhibiting this knowledge and just drawing their view of the model. Therefore the hidden handles of cups are omitted, the boundaries of objects are respected, and they completely omit totally occluded objects, and use *hidden-line elimination* (Freeman, 1980) to show partially occluded objects. This latter drawing technique involves only drawing a partial outline of the back object. For example, to draw two balls one partially occluding the other, the complete contour of the front ball is drawn, and a semi-circle is drawn onto the side of this, in order to depict the part of the back ball that can be seen, therefore eliminating the outline of the hidden section of the back ball.

One of the earliest demonstrations of intellectual realism was carried out by Clark (1897). He asked children to draw an apple with a hatpin pushed through it. He found that young children produced transparencies where the complete hatpin was drawn right through the outline of the apple. By eight to nine years of age the children began to draw the hatpin in two sections therefore omitting the middle part that could not be seen.

Freeman & Janikoun (1972) criticised Clark's study for using an unusual model that the children would have little, if any, prior experience of. By contrast they showed children a cup with a flower design on the outside and visible to the child, and oriented with its handle turned to the back and therefore hidden from the child's view. They used a cup because of its familiarity and therefore its potential to produce canonical drawings. Their model also allowed them to compare the effects of hiding the stereotypical or defining feature, and showing an additional non-defining feature, i.e. the flower design. They found a high incidence of canonical bias in the younger children, who drew the defining but hidden handle, and omitted the non-defining but visible design. By eight years of age the children stopped drawing the handle and started to draw the flower and therefore produced a visually realistic drawing.

These few early studies supported Luquet's theory of a developmental shift from intellectual to visual realism occurring around the age of eight years of age. However subsequent research has highlighted that this may not necessarily be the case, and that a young child may only be intellectually realistic in certain situations. Attempts have therefore been made to detail the circumstances under which visually realistic drawings will be produced by these young children.

1.3 THE VARIABLES AFFECTING THE PRODUCTION OF INTELLECTUALLY AND VISUALLY REALISTIC DRAWINGS

Task Demands

The demands placed upon the child in the testing situation have been shown to influence drawing performance. Is it possible to make the child understand exactly what the experimenter requires of them? Often it is argued that the child's interpretation of the requirements differs from what was actually intended (Cox, 1981; Light & Simmons, 1983). For example, a young child may interpret the task as requiring them to draw *all* the objects irrespective of whether they can be seen or not (Bremner & Batten, 1991; Cox, 1986). Older children correctly seem to interpret the task as requiring just those objects, or parts of objects, that they can see from their viewing position (Light & Simmons, 1983). Light (1985) believed that it may be a change in the child's interpretation of what the experimenter is asking them to do, that in part, marks the transition from intellectual to visual realism.

Is the young child's interpretation solely a product of their own cognitive abilities, or is it further affected by the lack of explicitness in the testing situation? As an older, and therefore more cognitively advanced child, can successfully interpret even standard procedures i.e. being asked to draw the objects in front of them, cognitive factors must play their part. However several researchers have found that variations in the task demands can lead the younger child to produce visually realistic drawings. For example, Light & Simmons (1983) introduced a communication game where one child had to draw a model from one of four viewing positions, so that the next child could use the drawing to determine where the drawer had sat. They found that this 'game' led seven- and eight-year-olds to produce a visually realistic drawing. However when presented with the standard testing situation i.e. they just have to draw the model for the experimenter, this same age group produced intellectually realistic drawings.

Labelling and Inspection Procedures

Controlling for prior naming and/or viewing of the objects to be drawn, has also been shown to increase visual realism. One of the major criticisms of Freeman & Janikoun's (1972) study was that they may have found a high incidence of canonical bias with cup drawings because, they had first asked the children to draw an imagined cup and had allowed them to examine and name the cup model before drawing. All of the imagined cup drawings contained a handle, and they had the opportunity to both see and feel the handle on the cup that they were subsequently asked to draw. Therefore it was not surprising that the young children took no notice of the fact that the cup was placed with its handle hidden from view, and just proceeded to draw a cup with a handle.

Bremner & Moore (1984) suggested that these procedures actually prompt the child to produce a canonical representation, or they suggest that a drawing of an *unambiguous* cup is required. By controlling for both these factors Bremner & Moore found a higher incidence of visual realism. For the six-year-olds who were allowed to visually inspect an unnamed cup before it was placed to be drawn with its handle hidden from view, forty percent of them produced a visually realistic drawing. When the object was named but not visually inspected before drawing, this figure was only fourteen percent. However with no naming and no visual inspection ninety-three percent of the six-year-olds omitted the hidden handle and were therefore visually realistic.

Lewis, Russell & Berridge (1993) allowed children to inspect a transparent mug, but then varied the way it was labelled or named in the instructions. It was either referred to as "this", as a "mug" or as a "glass". They found that labelling the object as a glass led to an increased number of five-year-old children being visually realistic (73%), while the "this" label produced visually realistic drawings in 52% of the children, and the "mug" label 31%. They therefore concluded that this procedure was an extension of Bremner & Moore's findings as it was not just whether the object was named or not, but also how it was named that affected drawing performance. However, if it is the case that children produce canonical representations and therefore do not refer to the model itself while drawing, it is possible that what the children drew in the "glass" label condition was a canonical representation. A glass does not stereotypically have a handle, therefore this drawing would then appear to be visually realistic when in fact it might be an intellectually realistic drawing. Similarly, the "mug" label may have led to increased handle inclusion as a mug does stereotypically have a handle.

Contrasting Models

The standard cup drawing task involves placing the cup with its handle hidden from view and asking the children to draw this exactly how it looks from where they are sitting. In this situation young children generally draw the hidden handle. Davis (1983) showed that five- and six-year-old children could be made aware of the task demands, i.e. that the orientation of the cup was important, by placing a contrasting cup (handle visible at the side) beside the 'target' cup i.e. the one the child has to draw (handle hidden from view). With this paired cup task there was a higher incidence of visually realistic drawings, compared to a single cup task where the target cup was placed on its own. In the first instance 77% of children were visually realistic as opposed to 59% with the single cup.

Order of Presentation

Davis' (1983) study also highlighted how the order of presentation of tasks could affect performance. If presented with the paired cup task first, then the single cup task, more children produced two similar visually realistic drawings in that they correctly omitted the hidden handle on both occasions. If however the reverse order was presented the child was more likely to change their response over the two tasks, i.e. to be intellectually realistic with the single cup, then visually realistic with the paired cup task. Davis therefore argues that the paired cup task aids interpretation of the task demands, by providing a contrast between the orientations of the cups.

Davis & Bentley (1984) demonstrated the same effect when the contrasting cups were presented in successive tasks rather than paired together within one task. They found that previously drawing a cup with its handle visible, led to reduced levels of intellectual realism on a subsequent drawing of a cup with its handle hidden from view. If the reverse order was presented, the child was more likely to produce an intellectually realistic drawing of the cup with its handle hidden. The only difference between the two tasks was the presence or absence of the handle, therefore by providing this contrast the child realises that the task requires them to portray the orientation of the cup in their drawing from the perspective of their viewing position.

Defining and Non-Defining Features

The handle is the defining feature of a cup and therefore this may contribute towards the production of intellectually realistic drawings. The child appears to believe that a cup is only a cup if the handle is drawn. As discussed earlier, Freeman & Janikoun (1972) showed that children who were asked to draw an imagined cup always included the handle. When these same children were shown a cup and asked to draw it, the tendency to stop drawing the hidden defining handle coincided with the tendency to start drawing the non defining flower design on the outside of the model cup. The intellectually realistic children where therefore over concerned with drawing the handle and ignored the flower altogether, while the visually realistic children were only concerned with drawing their view of the object irrespective of defining or non defining features.

The results reported by Davis (1983) and Davis & Bentley (1984) could possibly be affected by the fact that the cup has a defining feature. The handle can only be visible or not. It would be difficult, if not impossible, to show a model with a partially occluded handle, unless the children's head movements were restricted. Taylor & Bacharach (1982) presented the child with a cup with a broken handle and found that both five- and eight-year-olds were visually realistic when this broken handle was turned away from view. This suggests that removal of the defining feature leads to reduced levels of intellectually realism.

It is possible that these reported order effects may not be evident with models that do not have defining features. Arrowsmith, Cox & Eames (1994) however found that five-year-olds could draw one orange partially occluded by another orange (no defining feature), if they had previously drawn a boy partially occluded by an orange. Therefore the contrast between these two models aided drawing performance. However, although they were generalising their ability from one partial occlusion task to another in the same way as the paired cup task aided performance on the subsequent single cup task in

Davis' experiment, these two contrasts were quite different. In the Davis study the objects remained the same and a feature was either hidden or visible, while in the Arrowsmith *et al.* study the objects were different and both models were a partial occlusion. Therefore it is unclear whether a contrast between different models with no defining features e.g. ball models, would affect performance or not.

<u>Instructions</u>

Greater understanding of the task demands can also be achieved by increasing the 'explicitness' of the instructions. Barrett & Bridson (1983) found that by increasing the level of explicitness of the instructions (stressing the child's own view of the model) they could systematically increase the incidence of visual realism for a group of children aged between four years seven months and seven years five months. Although Barrett & Bridson had succeeded in promoting visual realism, one of the models they used was complex (a house), and they combined their data across a large age range and therefore did not distinguish between different age groups.

Cox (1981 Study 2) showed five-year-olds one ball totally occluding another and stressed the *behind* relationship in the instructions. She found that these young children were sensitive to these more explicit instructions. The five-year-olds produced a vertical-separate instead of a horizontal-separate (produced in response to standard instructions) in order to represent the depth relationship in this model. However these results were a comparison of two separate studies, and therefore the more explicit instructions were not directly compared to standard instructions within the one task.

Barrett, Beaumont & Jennett (1985) therefore conducted a series of experiments to assess instructional effects further. They believed that the instructions aid the child's interpretation of the task demands, which in turn provides the basis for the child's decision regarding which drawing strategy to employ. The standard instructions often used, for example "Make me the best drawing that you can" (Light & Humphreys, 1981), are thought to be ambiguous and may in fact promote intellectual instead of visual realism. It could be argued that these standard instructions do not provide enough information in order to make the correct interpretation of the task demands.

Barrett *et al.* asked children ranging from five years to seven years six months to draw a partially occluded ball model under two instruction conditions. The standard instructions asked the children to draw the model "exactly as you can see it from where you are sitting", while the explicit instructions further added "look very carefully at it while you are drawing it so that you can draw it just as you see it". They found that it was not until six and a half years of age that a child became sensitive to these instructions, with 11% of this age group producing visually realistic drawings with the standard instructions and 65% with the explicit instructions. They therefore concluded that these explicit instructions aid the child's interpretation of the task demands.

Barrett, Sutherland & Lee (1987) queried whether it was the additional length of the explicit instructions that led to increased performance levels. However they demonstrated that it was the content of these instructions, and not their length, that induced visually realistic drawings in seven- and eight-year-olds. Both lengths (20 and 44 words) of explicit instructions requested a visually realistic drawing of the model in front of the child, while both the inexplicit instructions requested any type of drawing of the model. The long explicit instructions were very similar to those used by Barrett *et al.* (1985), while the short explicit instructions asked the children to "draw these balls as carefully and exactly as you see them". The phrasing of the explicit instructions therefore seems to provide the necessary information for correct interpretation of the task.

<u>Attentional Strategies</u>

Why do these explicit instructions prompt six- and seven-year-olds to be visually realistic when standard instructions do not? Closer inspection of the instructions used by Barrett *et al.* (1985) shows that they asked the child to "look very carefully" at the model. It could be that these instructions prompt the child to pay more attention to the model in front of them, and that this leads to an increase in visual realism. Even the short explicit instructions used by Barrett, Sutherland & Lee asked them to draw the balls "carefully and exactly as you see them". However little research has been conducted into attentional processes in children's drawings. Mitchelmore (1978) found that seven-year-olds rarely looked at the model more than once, while fourteen-year-olds looked more often. Attention therefore seemed to increase with age. However Mitchelmore does not state how attention was assessed and there were methodological problems with the study. For example the drawing models were complex, each child had to draw each model twice (in succession) under different conditions, and the two conditions were not counterbalanced.

Cox (1991) thought that partially occluded dissimilar objects led to increased visual realism because a child was unable to hold a mental image of both objects, and therefore looked again after completing the drawing of the first object. By looking again the child takes note of the second object and the fact that only part of it is visible. However Nieland & Cox (cited in Cox, 1991) asked five- to six- and seven- to eight-year-old children to look again at a partial occlusion model, once the first object had been drawn. This increased attention had no significant effect on performance levels, however it is unlikely that the child knew why they were told to do this. Therefore it is possible that their increased looking was non-productive because it was not a spontaneous strategy.

Structurally vs. Visually United Features

Cox (1985) suggested another factor that has been shown to influence drawing performance. She noted that children often attempt to show the distinction between structurally and visually united features of a model. If features are structurally united young children attempt to show this in their drawings. For example, they will draw the canonical representation of a cup to show that the handle is structurally part of the whole object, irrespective of whether they can see the handle or not. However if two objects are structurally separate but visually united (as in a partial occlusion model), children will tend to separate them out either horizontally or vertically, in order to show the structural separation of the two objects.

Clark's (1897) model of a hatpin through an apple was both structurally and visually united. This may explain why children under the age of eight produced transparency drawings, in that they were concerned with maintaining the structural relationship between the two objects. In contrast the older children concentrated on their visual perspective of the model. Freeman (1980) replicated these findings, but also presented a visually identical, but structurally different model, in that the hatpin was placed behind the apple. In this situation the younger children depicted this structural relationship by still drawing two complete objects, but they were drawn separately on the picture plane, not as a transparency. These children appeared to be concerned with the drawing being unambiguous with regard to the structure of the model, i.e. whether the hatpin was behind or through the apple, while this appeared to be of no concern to older children who concentrated on depicting the visual relationship of the two objects.

Cox (1981, Study 1) also reported how young children separate visually united objects. She asked five-year-olds to draw two funnels that were either placed one beside the other, or one behind the other. Both arrangements resulted in the children drawing two separate funnels. Even when the 'behind' relationship was pointed out to the children, this time with a model of one ball totally occluding another, separate drawings were still produced up to seven years of age (Cox, 1981, Study 2). However, in both these studies the two objects were of different colours and the child was presented with crayons of these same two colours. This could have prompted the child to think they were required to draw both the objects. Cox & Martin (1988) placed a small green cube behind an opaque black beaker but did not use coloured crayons. They found that even five-year-olds omitted the cube altogether. This therefore contradicted the previous literature and suggested that when two objects are not structurally linked, the young child does not necessarily show a tendency to draw the hidden object, in the same way that they do tend to draw the hidden handle on a cup.

<u>Communication Games</u>

Other studies have tried to increase the incidence of visual realism for total and non-occlusion models by presenting the task as a game. Both Light & Simmons (1983) and

Smith & Campbell (1987) placed a red and blue ball one directly behind the other, on a table with four chairs positioned around it. Therefore from two of the chairs the child's view was of two balls one beside the other, and from the other two chairs the child's view was of a total occlusion model. The first child had to draw their own view of the model, so that the next child could use this drawing in order to select which of the four chairs the first child had been seated at when they produced the drawing.

Although Light & Simmons showed that this game situation led to increased visual realism compared to a control condition for seven- to eight-year-olds, Smith & Campbell found that children continued to produce vertical separates at this age irrespective of game or control condition. When they asked the children why they had produced such a drawing, they stated that they thought this would be the best cue for the second child. The children where therefore concerned with producing a drawing for their peers and not for the adult experimenters, i.e. they did not produce a visually realistic drawing. However both these studies presented the children with coloured pens, so again this may have confounded the results.

<u>Occlusion Models</u>

In the Light & Simmons study the five- and six-year-olds failed to produce varying results between the control and game conditions. As discussed earlier, Barrett, Beaumont & Jennett (1985) also found that children in this age range were insensitive to changes in instructions. The five- and six-year-olds showed no difference in their levels of visual realism between the standard and explicit instructions, while the seven- and eight-year-olds did. The partial occlusion ball model used by Barrett *et al.* seems to present the child with a complex drawing problem. It is widely documented that the successful use of hidden-line elimination in drawings does not develop until around eight years of age (Freeman, 1980). Lewis, Russell & Berridge (1993) however found that explicit instructions increased visual realism for five-year-olds, although this was with a cup model.

Cox (1991) believed that when an object was completely hidden, as with the Cox & Martin study, most children do not see the necessity to draw it. However when *part* of the back object is visible, as in the case of a partial occlusion model, children have the tendency to believe both objects should be drawn, and therefore continue to produce drawings of the two separate objects. Only when the instructions become explicit does the child realise that they are required to draw the objects exactly how they appear from their particular viewpoint.

Cox (1981) took this approach further by trying to make the drawing task more 'meaningful'. She felt that from the child's point of view there was no purpose in hiding part of one ball behind another ball. Therefore she placed a toy 'robber' behind a 'wall' so that his head could still be seen above it. The child then had to draw what they could see of the 'robber' while they pretended to be a 'policeman'. They were therefore presented with a realistic scene that they could identify with. The majority of six-year-olds and even 44% of four-year-olds were capable of producing partial occlusion drawings. Arrowsmith, Cox & Eames (1994) also found that hiding a boy behind an orange led to increases in visual realism in four- and five-year-olds.

Cox (1985) went on to manipulate various combinations of objects, one partially occluding the other. She found that the more dissimilar the two objects the more likely the child was to produce a visually realistic drawing, but that the four-year-olds *also* required a more realistic task. Perhaps the dissimilarity between the cube and the beaker used by Cox & Martin also contributed to the increase in visually realistic drawings in this total occlusion task.

Partial occlusion models therefore seem to be difficult to draw, particularly if the two objects are identical. Chen & Holman (1989) directly compared performance on a cup and ball task and concluded that the ball task was more difficult. At seven years of age 94% of children were able to omit the hidden handle of the cup, but only 54% were able to use hidden-line elimination to show the partially occluded ball. In agreement with Freeman (1980), it was not until nine years of age that 91% of their sample were producing visually realistic ball drawings. However they presented a simultaneous contrast with a cup with its handle visible placed next to a cup with its handle hidden from view. Similarly, two balls were presented side by side, beside the partial occlusion ball model. The children then had to draw the two cup models and the two ball models. As discussed earlier, Davis (1983) demonstrated that such a simultaneous contrast leads to increased visual realism, although the children only had to draw the 'target' cup and not the contrasting one as well.

It is unknown whether this contrast effect would also be evident with a comparable ball task. Whilst this is a distinct possibility, there is a fundamental difference between the two tasks. The cup is a total occlusion task, while the ball is a partial occlusion task. As mentioned earlier when part of an object is visible the child might think that they are required to draw it, while a totally occluded feature/object is often ignored (Cox, 1991). Chen & Holman state this as the reason why the ball task was more difficult, i.e. why the majority of children did not successfully use hidden-line elimination until nine years of age. However, it might not be that the ball task was more difficult, just that the intentions of the experimenter were less clear. The instructions emphasised the depth relationship, i.e. 'behind'. Cox (1981, Study 2) showed that although this produced a change from horizontal to vertical separates, it did not lead to the production of visually realistic drawings. This could be because they led the child to believe that their attention is being drawn to the back object/feature because they are required to draw it. Possibly, Barrett *et al.'s* (1985) explicit instructions have a beneficial effect because they stress 'looking' and therefore draw attention towards the whole model, and not just specific features.

1.4 CURRENT THEORETICAL PERSPECTIVE

The evidence discussed in this chapter shows that visual realism can be manipulated in young children. The fact that the stages described by Luquet can disappear with some procedural changes, seriously questions his stage approach to the study of drawings. The current research suggests that other factors could be influencing the type of drawing produced by the child. Children's drawings do not develop in isolation of other abilities, and in order to understand them fully they need to be studied within the context of general cognitive development. Current theoretical perspectives do not seem to take this into account, and therefore it can be argued that there is a need for new theoretical perspectives of the development of children's drawings.

1.5 PLAN OF THESIS

There are many variables that seem to determine whether or not a young child will produce intellectually or visually realistic drawings. Although these have been highlighted by many studies it is difficult to integrate the results due to variations in methodologies, instructions and the drawing models. The following chapters therefore assess the effects of some of these variables under consistent conditions. Chapter 2 details the first study which undertook the initial priority of demonstrating the apparent developmental trend from intellectual to visual realism. Various cup models were presented with standard instructions and procedures. This study also aimed to make a preliminary assessment of the amount of attention that children actually pay towards the drawing model. Study 2 (Chapter 3) then details how this relationship is affected by presentation order, instructions, and denying the children the opportunity to attend to the cup model. Study 3 (Chapter 4) assesses the effects of order and instruction but with a ball drawing model. Study 4 (Chapter 5) further assesses whether removal of the possibility of continued attention to a cup model leads to a deterioration in the drawing performance of older children. The remaining chapters detail a longitudinal assessment of the development of drawing performance and attention to the model, and attempts to put this in the broader context of cognitive development.

CHAPTER 2

STUDY 1
PRELIMINARY ASSESSMENT OF DRAWING DEVELOPMENT AND ATTENTION PAID TO THE DRAWING MODEL

2.1 INTRODUCTION

As discussed in Chapter 1, Luquet (1913, 1927) believed that children between the ages of five and eight produced intellectually realistic drawings in that they were unable to inhibit their knowledge and just draw the parts of an object that they can see from their viewing position. After the age of eight, Luquet believed a child could draw in a visually realistic way by inhibiting this knowledge, and just drawing their view of the model placed in front of them. However subsequent research has shown that manipulation of the demands placed upon the child in the testing situation can influence drawing performance.

Davis (1983) showed that five- and six-year-old children could be made aware of the task demands, i.e. that the orientation of the cup was important, by showing the children a cup with its handle visible to the side, beside the cup which the child is asked to draw, which has its handle hidden at the back and therefore out of view. This contrast led to these young children producing visually realistic drawings, i.e. they omitted the hidden handle. Davis & Bentley (1984) demonstrated the same effect when the contrasting cups were presented in successive tasks rather than paired together within one task. They found that previously drawing a cup with its handle visible, led to increased levels of visual realism on a subsequent drawing of a cup with its handle hidden from view.

Another procedural variable ignored by early researchers was highlighted by Bremner & Moore (1984). They suggested that the prior inspection and naming of objects prompts the child to produce a canonical representation, or suggests to them that a drawing of an unambiguous cup is required. The child has been able to see that the cup has a handle, and has been told that it is a 'cup'. By controlling for both these factors Bremner & Moore found a higher incidence of visual realism.

Similarly, Barrett, Beaumont & Jennett (1985) showed that by increasing the explicitness of the instructions they could increase the incidence of visually realistic drawings. They directly compared both standard and explicit instructions and found that children aged six years and six months could produce visually realistic drawing of a partial occlusion ball model with the explicit instructions, but were intellectually realistic with the standard instructions.

Freeman (1980) criticised many of these researchers for just assessing the final drawing and not the drawing processes involved in producing this. He believed that the sequencing of parts may affect whether the final product is intellectually or visually realistic. It may be the case that intellectually realistic drawings of a cup with its handle hidden from view, are produced because the child starts by drawing the handle, and is therefore committed to producing an incorrect drawing of their view. In order to assess sequencing it would be necessary to video the children while they drew. This would also provide the means of assessment of a further, largely ignored variable.

Little research has been conducted into attentional processes in children's drawings. Mitchelmore (1978) found that seven-year-olds rarely looked at the model more than once, while fourteen-year-olds looked more often. Attention therefore seemed to increase with age, although it is unclear how Mitchelmore actually measured this. Nieland & Cox (cited in Cox, 1991) asked five- to six- and seven- to eight-year-old children to look again at a partial occlusion model, once the first object had been drawn. This increased attention had no significant effect on performance levels, however it is unlikely that the child knew why they were told to do this. Therefore it is possible that their increased looking was non-productive because it was not a spontaneous strategy. If spontaneous attention towards the model can be shown to increase with age, it would be interesting to see if there was a relationship between this and the reported increase in visual realism with age.

There are, therefore, many task variables that seem to affect drawing performance. However, it is difficult to integrate the results of the many studies conducted due to variations in methodologies, instructions and the drawing models. The initial priority was therefore to demonstrate the apparent developmental trend from intellectual to visual realism using standard procedures. As this transition is reported to occur around six years of age, four-, six- and eight-year-old age groups were selected. Objects were named but not visually inspected, as controlling for both factors has been shown to lead to increased visual realism, and naming alone has been shown to elicit intellectual realism (Bremner & Moore, 1984). The standard instructions presented to the children were adapted from Barrett *et al.* (1985).

Five different tasks were used in order to provide a wide selection of drawings at the different ages. Cups were chosen because of their familiarity and the fact that they have a defining feature that can be hidden from view, in order to prompt canonical representations. The tasks consisted of two, single cup models one with the handle hidden from view, and one with its handle visible to the side, but also with a spoon placed inside the cup in order to prompt transparency drawings. Three, two cup models including both partial and total occlusions were included to prompt the children to separate out visually united objects.

The novel aspect of the study was to video the children. This would provide data to assess the sequencing of the drawings and the children's attention towards the drawing model.

The hypotheses for the drawing data were that:-

1: The transition from intellectual to visual realism would occur around six to seven years of age.

2: Prior exposure to a handle would increase visual realism on subsequent tasks where the handle was hidden from view.

3: The more complex tasks would result in reduced levels of visual realism.

The hypotheses for the video data were that:-

1: Intellectual realism would be associated with drawing the handle first.

2: With age the children would pay more attention to the model.

3: The more complex tasks would result in increased attention.

4: Younger children would look at the model at the beginning of the task while the older children would continue to look while they drew.

5: Holding complexity constant, increased visual realism would be associated with increased attention.

2.2 METHOD

2.2.1 SUBJECTS

Ninety subjects were randomly selected by the experimenter from the relevant classes in one Plymouth school. There were thirty children in each age group with mean ages of 4 years 4 months (range 3:11 to 4:8, standard deviation 0:3 months), 6 years 4 months (range 5:8 to 7:7, standard deviation 0:7 months) and 8 years 4 months (range 7:9 to 9:4, standard deviation 0:5 months). There were 15 males and 15 females in each age group.

2.2.2 DESIGN

A 3 (age) x 5 (task) design was conducted, with independent groups for the first factor and repeated measures for the second. The independent variables were age and task. The dependent variables were, for the drawing data, classification of the drawings as intellectually and visually realistic, and for the video data, the sequencing of separate elements of the drawing and the amount of attention paid towards the drawing model.

2.2.3 MATERIALS

Two plain white coffee mugs, with handles, measuring 9.5 cms. high and 8 cms. wide, and a teaspoon measuring 13 cms. long were used as drawing models. These were placed on 3 separate inverted boxes measuring 15 cms., 26 cms. and 32 cms. high for the 4-, 6- and 8-year-olds respectively, in order to ensure presentation at eye-level. Plain A5 paper and a black pencil were given to the children to draw with.

2.2.4 PROCEDURE

Each child was tested individually by the same female experimenter in a private room at the school. After establishing rapport, the child was asked to sit squarely at a table where an inverted box had been placed directly in front of them. The height of this box varied with the age group in order to ensure that the model was placed at approximately the child's eye-level. The centre of the box was at a distance of 60 cms. from the child. Preferably the model should have been placed at a greater distance from the child, as this reduces the possibility of the child looking from side to side in order to view the occluded object(s). As the distance increases the child would need to move their head further in order to do this. However the distance was constrained by the size of the table available at the school.

A video camera was angled to observe the child's direction of gaze and the drawing area in front of them. The experimenter tried not to draw too much attention towards the camera's presence in the room, by keeping contact with it to a minimum.

The child was given a plain piece of paper and a black pencil. The experimenter stated "I am going to ask you to do five drawings for me. Each time I want you to draw exactly what you can see from where you are sitting".

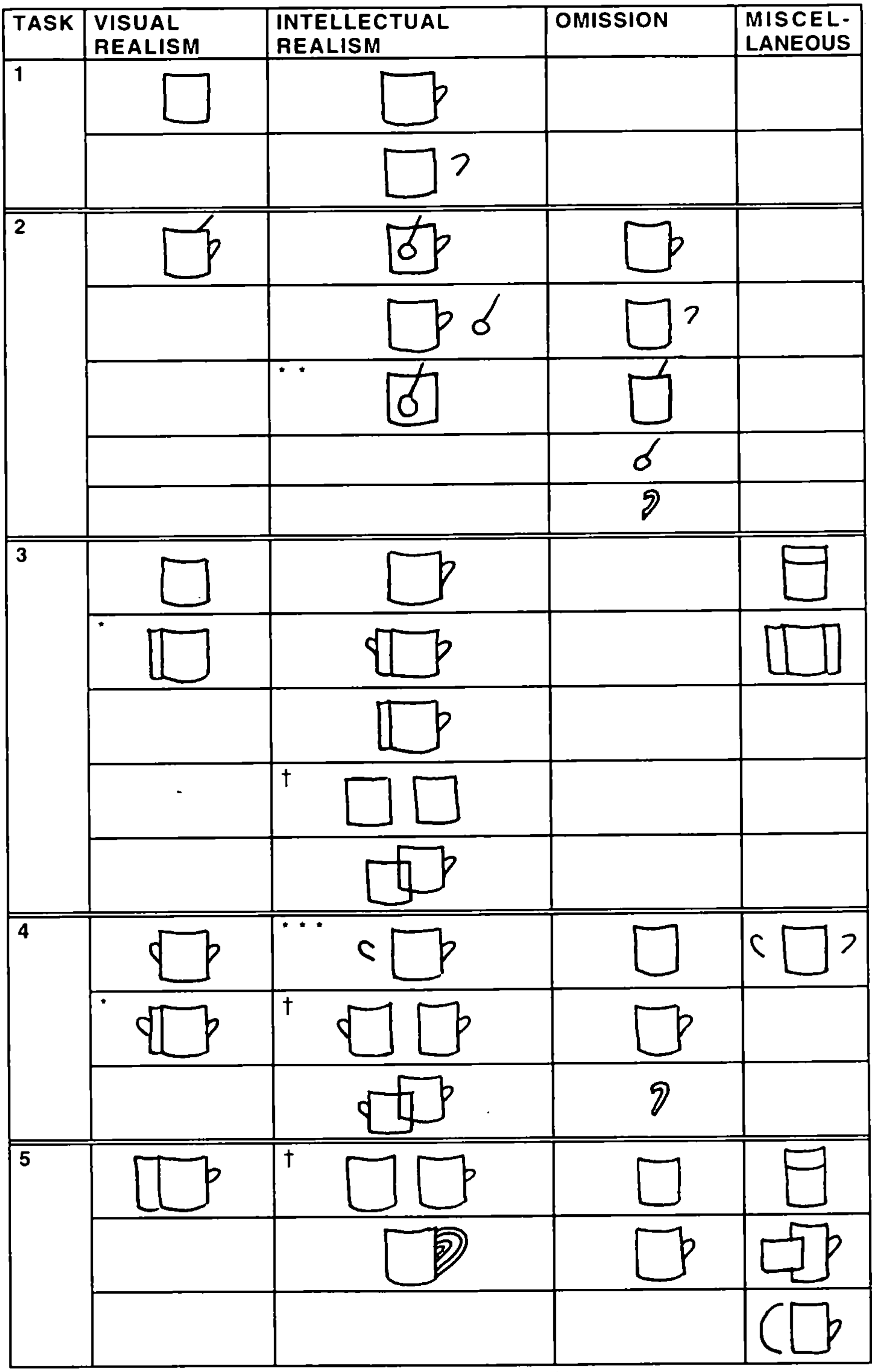
The following five tasks were then presented in a random order. For each task a new piece of paper was provided, and the instructions were repeated while the model was placed in the centre of the inverted box. See Table 2.1 for the visually and intellectually realistic views of the five tasks.

<u>Task 1</u> consisted of a single cup with the handle turned to the back and therefore out of the child's view. The child was told "Here is a cup. Please draw exactly what you can see from where you are sitting".

<u>Task 2</u> consisted of a single cup with the handle turned to the right side and a spoon placed inside the cup, therefore the handle of the spoon was visible above the rim of the cup. The child was told "Here is a cup and a spoon. Please draw exactly what you can see from where you are sitting".

<u>Task 3</u> consisted of two cups both with their handles turned to the back. The second cup was placed directly behind the first cup and was therefore totally occluded. The child's view was the same as Task 1. The child was told "Here are two cups. Please draw exactly what you can see from where you are sitting".

TABLE 2.1 CLASSIFICATION OF DRAWINGS



* Classified as visually realistic due to shared boundary.

* * Classified as intellectually realistic as included the hidden feature.

* * * Classified as intellectually realistic as separates the handle belonging to the back cup.

† With or without handle(s).

Task 4 consisted of two cups. The front cup was placed with its handle turned to the right. The second cup was placed directly behind the first but with its handle turned to the left. The child's view was therefore of one cup with two handles or a 'baby cup'. The child was told "Here are two cups. Please draw exactly what you can see from where you are sitting".

Task 5 consisted of two cups. The front cup was placed with its handle turned to the right. The second cup was placed behind but slightly to the left of the front cup and was therefore partially occluded. The handle of the back cup was turned to the right and therefore totally occluded by the front cup. The child was told "Here are two cups. Please draw exactly what you can see from where you are sitting".

If the child was unsure of what (s)he was required to do, the instructions were repeated. The children were given as long as they required to complete each drawing. Each child was praised for their drawings and thanked for their help.

2.2.5 SCORING

DRAWING DATA

Each child's five drawings were classified into one of five categories i.e. visually realistic, intellectually realistic, omission, miscellaneous and scribbled.

1: A visually realistic drawing consisted of only those elements of the model that could be seen from the child's viewing position. For Tasks 3 and 4 partial occlusions showing part of the back cup with a shared boundary of the front cup were also included. This was due to the problem associated with the model not being far enough away to prevent the child moving their head from side to side, and therefore seeing a slightly different view to the one intended.

2: An intellectually realistic drawing either contained features that were not visible and/or separate discrete objects that were visually united in the model.

3: Omission drawings omitted features that were visible.

4: Drawings that could not be reliably classified by these criteria were classified as miscellaneous.

5: Drawings without any recognisable features were classified as scribbled.

Examples of the first four categories of drawings obtained in each task are shown in Table 2.1.

In order to establish inter-judge reliability, 10% of the subjects were randomly selected and their drawings were re-classified by a second independent judge. Classification showed an 86% agreement. The Kappa statistic [for assessment of categorical data (Siegel & Castellan, 1988)] showed a strong agreement between judges, which was found to be significantly different from zero (K=0.88, Z=5.25 p<.001). The classifications of the first judge were used in the subsequent analyses.

<u>VIDEO DATA</u>

SEQUENCING

The order in which the child drew each separate element of the model was noted. For example Task 1 had two possible elements i.e. the body of cup (B) and the handle (H). A child could therefore be classified into one of the five possible categories i.e. B, H, BH, HB or scribbled.

In order to establish intra-observer reliability, 10% of the subjects were randomly selected and their sequencing was re-assessed. There was a 91% agreement overall. The Kappa statistic [for assessment of categorical data (Siegel & Castellan, 1988)] showed a strong agreement between assessments, which was found to be significantly different from zero (K=0.90, Z=14.96 p<.001). The classifications of the initial assessment were used in the subsequent analyses.

ATTENTIONAL BEHAVIOUR

Each child's attention towards the model in front of them was scored in two ways. Firstly the number of looks and secondly the time spent looking at the model. These two measures were divided into the Number of Looks or Looking Time at the 'beginning' of the task before drawing commenced; 'between' drawing separate elements of the model; 'within' drawing a particular element, and at the 'end' of the task after the drawing had been completed.

In order to establish intra-observer reliability, 10% of the subjects were randomly selected and their attention was re-assessed. Pearson Product Moment correlations were used to compare the relationship between the first and second assessments, separately for each attentional measure. There were a high number of zero scores due to a high proportion of subjects only looking at the 'beginning' of the task. It was felt that inclusion of these scores would adversely affect the analyses. The correlation on the remaining data showed strong relationships for both the Number of Looks and Looking Time measures ($r=0.82$ and 0.91 respectively, $d.f.=71$ $ps<.001$).

Due to the zero scores being omitted from the correlation, intra-observer reliability of classification of attention into the four look types was assessed using the Phi Coefficient [for use with nominal data (Siegel & Castellan, 1988)]. There was a 95% agreement overall, which represented highly significant associations for the 'beginning', 'between', 'within' and 'end' look types ($r\phi$ = 1.0, 0.95, 0.92 and 0.81 respectively). These scores were shown to be significantly different from zero (X^2 = 11.25, 35.70, 31.97 and 22.78 respectively, $ps<.001$).

The reliability assessment of the video data was conducted on an intra-observer basis due to the scoring of the children's sequencing and attention being a lengthy and complex procedure.

2.2.6 DATA ANALYSIS

DRAWING DATA

The proportions of children producing intellectually and visually realistic drawings were analysed using the Chi-Square test for independent samples. Where the observed set of frequencies formed a 2 x 2 contingency table, the Yates correction for continuity was applied (Siegel & Castellan, 1988). Where any expected cell frequencies were less than five the Fisher Exact Probability test was used (Siegel, 1956). Log-linear modelling, which allows for analysis of frequency data with two or more discrete categorical variables, was not applicable due to Task being a repeated measure and the statistical procedure requiring between-subject measures.

Task effects were calculated using the Cochran Q test for related samples (Siegel, 1956). As no specific follow-up analysis was available the McNemar test for significant changes was used, however the significance level was set at 0.025 rather than 0.05. If the expected cell frequencies were less than five the Binomial test was used again with a 0.025 significance level (Siegel, 1956).

ATTENTIONAL DATA

Analysis of Variance (ANOVA) was used to assess the amount of attention paid towards the drawing model. Where the assumption of homogeneity of variance between conditions was not met, transformations were performed on the raw data according to the criteria detailed in Howell (1987). Significant differences were assessed using Scheffe's method of multiple comparison of means (See Appendix A for full details).

2.3 RESULTS

2.3.1 DRAWING DATA

The number of children in each age group producing the five different categories of drawings for each task are shown in Table 2.2.

Age Effects

Chi-Square and Fisher Exact Probability tests showed that for all tasks, the eight-year-olds produced significantly more visually realistic drawings than both the four- and six-year-olds (ps<.05). The four-year-olds produced equivalent levels of visual realism to the six-year-olds, most noticeably in Task 1, and were therefore less intellectually realistic than expected.

Order Effects

The increased performance of the four-year-olds was possibly accounted for by the significant order effect. A four- or six-year-old child who was presented with Task 1 first, was more likely to be intellectually realistic on this task i.e. include the hidden handle, than a child who was presented with Tasks 2, 4 and/or 5 (containing one or more visible handles) prior to completing Task 1 (Fisher Exact Test p<.01). This was also the case if those children who were presented with Task 3 first, followed by Task 1, were included in the analysis (Fisher Exact Test p<.05). Therefore prior exposure to a cup with a visible handle led to greater visually realism on Task 1 where the handle was hidden from view.

Task Effects

Table 2.2 also details how the number of visually realistic drawings varied between the five tasks. Cochran tests were used to assess these task effects separately for each age group. These effects were significant for each age group (Cochran Q=26.53 d.f.=4 p<.001, Q=11.80 d.f.=4 p<.05 and Q=15.52 d.f.=4 p<.01 for the 4- 6- and 8-year-olds respectively). Pairwise comparison of tasks for the four- and eight-year-olds showed

TABLE 2.2 FREQUENCY OF DRAWINGS FOR EACH TASK

TASK	AGE	N	VISUAL REALISM	INTEL-LECTUAL REALISM	OMIS-SION	SCRIB-BLED	MISCEL-LANEOUS
1	4	30	12	12	0	4	2
	6	30	15	15	0	0	0
	8	30	30	0	0	0	0
2	4	30	3	3	21	3	0
	6	30	21	7	2	0	0
	8	30	28	1	1	0	0
3	4	30	9	16	0	3	2
	6	30	13	16	0	0	1
	8	30	27	2	0	0	1
4	4	30	1	6	17	3	3
	6	30	12	12	6	0	0
	8	30	23	5	2	0	0
5	4	30	1	6	17	3	3
	6	30	10	13	7	0	0
	8	30	23	2	3	0	2

that Task 1 produced significantly higher levels of visual realism than Tasks 4 and 5 (McNemar Tests ps<.01). For the six-year-olds pairwise comparisons showed that Task 2 produced significantly higher levels of visual realism than Task 5 (McNemar X^2=7.69 d.f.=1 p<.01). Therefore Tasks 4 and 5 proved to be the most difficult.

2.3.2 VIDEO DATA

Due to problems associated with the video equipment, data was unavailable for eleven 4-year-olds and four 8-year-olds. The following analyses were therefore performed on the remaining 75 subjects.

2.3.2.1 SEQUENCING

There were vast individual variations in the sequencing of separate parts of each drawing however most children tended to start with the body of the cup. Of those 4- and 6-year-olds who produced intellectually realistic drawings of Task 1 i.e. they drew the hidden handle, only one 4-year-old and two 6-year-olds started with the handle, as opposed to seven 4-year-olds and thirteen 6-year-olds who started with the body of the cup. A Chi-Square One-Sample test combining ages showed this difference to be significant (X^2=12.56 d.f.=1 p<.001). Therefore intellectual realism of a cup with the handle hidden from view was not the product of a child initially drawing the handle and therefore being committed to an incorrect drawing of their view of the model.

2.3.2.2 ATTENTIONAL BEHAVIOUR

The following sections detail the main findings of the attentional analysis. The full analysis of variance summary tables and details of the subsidiary results are given in Appendix B.

2.3.2.2.1 NUMBER OF LOOKS

A 3 (age) x 5 (drawing order) ANOVA was performed on the total number of looks, comparing the order of presentation irrespective of actual task. Due to unequal variances and these variances being proportional to the means, a square root transformation was performed on the data. See Table 2.3 for details of the mean scores.

TABLE 2.3 MEAN NUMBER OF LOOKS PER AGE AND DRAWING ORDER

AGE	N	FIRST TASK	SECOND TASK	THIRD TASK	FOURTH TASK	FIFTH TASK	MEAN TOTAL
4	19	1.14 (1.37)	1.04 (1.11)	1.07 (1.16)	1.00 (1.00)	1.02 (1.05)	**1.05 (1.14)**
6	30	1.48 (2.43)	1.28 (1.77)	1.19 (1.50)	1.25 (1.70)	1.34 (2.00)	**1.31 (1.88)**
8	26	2.47 (7.04)	2.17 (5.54)	2.06 (4.77)	2.00 (4.69)	1.88 (4.23)	**2.11 (5.25)**
MEAN TOTAL		**1.74 (3.61)**	**1.53 (2.80)**	**1.46 (2.48)**	**1.45 (2.46)**	**1.49 (2.43)**	

Untransformed means (number of looks) are shown in parentheses.

This showed a significant main effect of drawing order ($F(4,259)=8.27$ $p<.001^{*}$), in that the first task presented to the child produced greater looking than the four subsequent tasks (Scheffe ps<.01), irrespective of which task that was. There was a main effect of age ($F(2,72)=30.52$ $p<.001$) where the four- and six-year-olds looked less than the eight-year-olds, and a significant interaction between drawing order and age ($F(7,259)=2.34$ $p<.05^{*}$). This showed that only the eight-year-olds looked more on the first task presented to them, than they did on the fifth (Scheffe $F(7,259)=36.99$ $p<.01^{*}$). See Figure 2.1 for an illustration of these effects.

A second 3 (age) x 5 (task) x 4 (look type) ANOVA was performed on the number of times each child looked at the model in front of them. Due to unequal variances and these variances being proportional to the means, a square root transformation was performed on the data.

The ANOVA showed significant main effects of age ($F(2,72)=34.83$ $p<.001$) and task ($F(3,251)=5.70$ $p<.001^{*}$), and a significant interaction between these two factors ($F(7,251)=3.28$ $p<.01^{*}$). See Table 2.4 for details of the mean scores. Scheffe follow-up analysis showed that the 8-year-olds looked at the model significantly more than the 4- and 6-year-olds (Scheffe $F(2,72)=58.24$ and 37.84 respectively $p<.001$). Less overall attention was paid to Task 1 compared to Tasks 2 and 5 (Scheffe $F(3,251)=20.77$ and 17.70 ps<.01 respectively*). The interaction showed that the 8-year-olds looked more at Task 5 than at Task 1 (Scheffe $F(7,251)=33.41$ $p<.05^{*}$). The 8-year-olds were therefore changing their looking patterns to accommodate the varying task demands i.e. they looked more at the more complex model. These effects are illustrated in Figure 2.2.

The ANOVA showed a highly significant main effect of look type ($F(2,116)=95.40$ $p<.001^{*}$), in that more looks occurred at the 'beginning' of the task compared all other look types (Scheffe ps<.001). The 'end' looks were significantly lower than all other look types (Scheffe ps<.001). Follow-up analysis on the significant interaction between age and look type ($F(3,116)=21.59$ $p<.001^{*}$) showed that the 8-year-olds were looking

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 2.4 MEAN NUMBER OF LOOKS PER AGE AND TASK

AGE	N	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5	MEAN TOTAL
4	19	0.25 (0.25)	0.29 (0.30)	0.28 (0.28)	0.31 (0.32)	0.28 (0.28)	**0.28 (0.28)**
6	30	0.36 (0.38)	0.46 (0.53)	0.41 (0.46)	0.45 0.53)	0.40 (0.46)	**0.42 (0.47)**
8	26	0.65 (1.06)	0.86 (1.47)	0.74 (1.16)	0.72 (1.14)	0.93 (1.74)	**0.77 (1.31)**
MEAN TOTAL		**0.43 (0.56)**	**0.56 (0.77)**	**0.49 (0.63)**	**0.51 (0.66)**	**0.55 (0.83)**	

Untransformed means (number of looks) are shown in parentheses.

FIGURE 2.1 INTERACTION OF DRAWING ORDER BY AGE FOR NUMBER OF LOOKS MEASURE

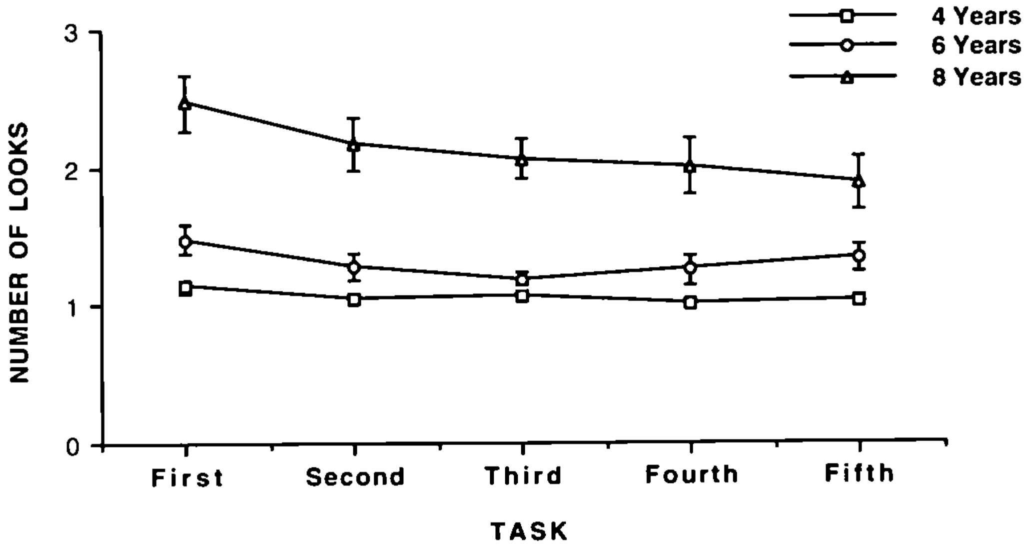
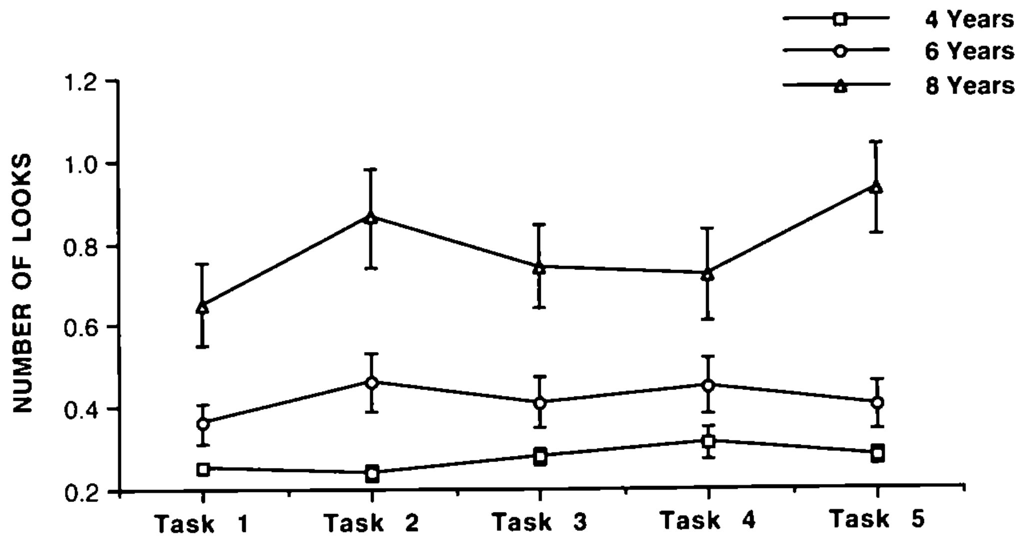


FIGURE 2.2 INTERACTION OF AGE BY TASK FOR NUMBER OF LOOKS MEASURE



significantly more 'within' than the 4- and 6-year-olds (Scheffe $F(3,116)=148.61$ and 150.99 respectively $p<.001$*). The 8-year-olds were therefore continually checking their drawing with what they could see in front of them. See Figure 2.3 for an illustration of this effect, and Table 2.5 for details of the means.

There were significant interactions between task and look type ($F(7,526)=5.38$ $p<.001$*) and age, task and look type ($F(15,526)=3.15$ $p<.001$*). Follow-up analysis showed that the 'between' looks varied predictably across task, while the 'beginning', 'within' and 'end' looks remained constant. The two tasks with the lowest number of elements (Tasks 1 and 3) predictably showed low 'between' looks, in particular Task 1 was significantly lower than Tasks 2, 4 and 5 (Scheffe $ps<.05$). See Table 2.5 for details of the means. Follow-up analysis of the three-way interaction showed the 8-year-olds varying their 'between' and 'within' looks, and the 6-year-olds varying their 'between' looks, predictably across tasks (Scheffe $ps<.05$).

Summary of Main Findings

1: The children paid more attention towards the first model presented to them, irrespective of which model this was.

2: Task 1 produced low levels of looking.

3: The eight-year-olds paid more attention to the model than the other two age groups, and varied their looking behaviour across the complexities of the tasks.

4: The highest levels of attention occurred at the 'beginning' of the task, however the eight-year-olds continued to look 'within' drawing separate elements of the model.

NUMBER OF LOOKS AND DRAWING REALISM

It was not possible to compare the looking behaviour of the intellectually and visually realistic drawers across tasks because a child did not necessarily fall into the same category of realism for each task. Therefore five separate 2 (drawing realism) x 3 (age) x 4 (look type) ANOVAs were performed, one for each task. For Task 1 there were no

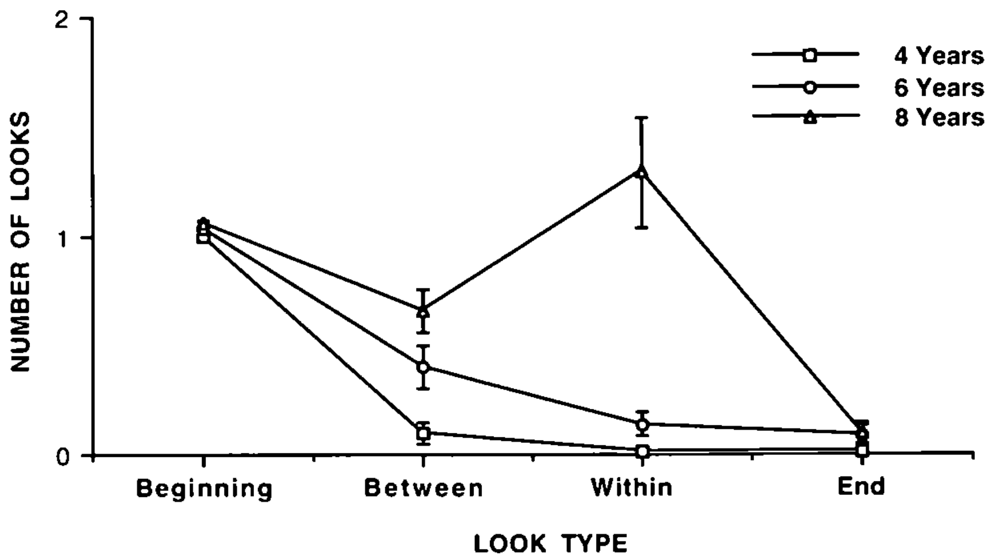
* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 2.5 MEAN NUMBER OF LOOKS PER LOOK TYPE, AGE AND TASK

AGE/ TASK	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
4 YEARS	19	1.00 (1.00)	0.10 (0.12)	0.01 (0.01)	0.01 (0.01)	**0.28 (0.28)**
6 YEARS	30	1.04 (1.09)	0.40 (0.53)	0.14 (0.16)	0.09 (0.10)	**0.42 (0.47)**
8 YEARS	26	1.06 (1.15)	0.66 (0.86)	1.29 (3.13)	0.10 (0.11)	**0.77 (1.31)**
TASK 1	75	1.02 (1.06)	0.13 (0.14)	0.50 (0.98)	0.07 (0.07)	**0.43 (0.56)**
TASK 2	75	1.04 (1.09)	0.57 (0.73)	0.54 (1.19)	0.08 (0.07)	**0.56 (0.77)**
TASK 3	75	1.04 (1.08)	0.37 (0.40)	0.46 (0.94)	0.11 (0.10)	**0.49 (0.63)**
TASK 4	75	1.05 (1.11)	0.51 (0.65)	0.40 (0.80)	0.08 (0.07)	**0.51 (0.66)**
TASK 5	75	1.03 (1.07)	0.50 (0.60)	0.63 (1.59)	0.04 (0.06)	**0.55 (0.83)**
MEAN TOTAL		**1.03 (1.08)**	**0.39 (0.50)**	**0.48 (1.10)**	**0.06 (0.07)**	

Untransformed means (number of looks) are shown in parentheses.

FIGURE 2.3 INTERACTION OF AGE BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE



intellectually realistic 8-year-olds for which video data was available and therefore this age group was omitted from the Task 1 analysis. Due to unequal variances and these variances being proportional to the means, a square root transformation was performed on the data.

Only Task 5 showed a significant main effect of drawing realism ($F(1,43)=4.92$ $p<.05$), in that the visually realistic drawers looked at the model more than the intellectually realistic drawers (mean number of looks 1.05 and 0.46 respectively). This task also showed a significant interaction between drawing realism, age and look type ($F(3,73)=3.77$ $p<.05$*). The visually realistic eight-year-olds showed high 'within' looking in that this was significantly higher than their 'end' looking (Scheffe $F(3,73)=163.73$ $p<.001$*). See Table 2.6 and Figure 2.4 for details of the means and an illustration of this effect.

Summary of Main Findings

1: Task 5 showed a significant relationship between increased attention towards the drawing model and the production of a visually realistic drawing.

2: For the eight-year-olds, visual realism was association with increased 'within' looking for Task 5.

2.3.2.2.2 LOOKING TIME

A 3 (age) x 5 (drawing order) ANOVA was performed on the total looking time comparing the order of presentation irrespective of actual task. Due to unequal variances and the standard deviations being proportional to the mean squares, a reciprocal transformation was performed on the data.

This ANOVA, like the results for the Number of Looks measure, showed a significant main effect of drawing order ($F(3,227)=14.12$ $p<.001$*). The first task presented to the child produced greater levels of looking than the third, fourth and fifth tasks (Scheffe

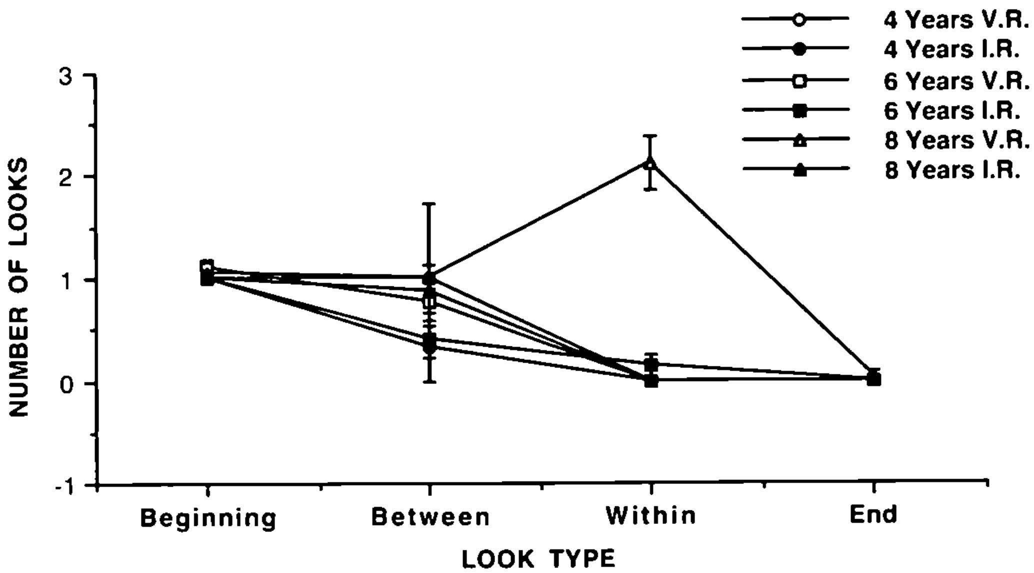
*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 2.6 MEAN NUMBER OF LOOKS PER DRAWING REALISM, AGE AND LOOK TYPE (TASK 5)

AGE	REALISM	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
4	Visual	1	1.00 (1.00)	1.00 (1.00)	0.00 (0.00)	0.00 (0.00)	
	Intellectual	3	1.00 (1.00)	0.33 (0.33)	0.00 (0.00)	0.00 (0.00)	**0.42 (0.42)**
6	Visual	10	1.11 (1.30)	0.76 (1.00)	0.00 (0.00)	0.00 (0.00)	
	Intellectual	13	1.00 (1.00)	0.40 (0.54)	0.15 (0.15)	0.00 (0.00)	**0.43 (0.50)**
8	Visual	20	1.05 (1.15)	1.01 (1.25)	2.12 (5.80)	0.05 (0.05)	
	Intellectual	2	1.00 (1.00)	0.87 (1.50)	0.00 (0.00)	0.00 (0.00)	**0.76 (1.34)**
MEAN TOTAL			**1.05 (1.06)**	**0.75 (0.94)**	**0.91 (0.99)**	**0.02 (0.01)**	

Untransformed means (seconds) are shown in parentheses.

FIGURE 2.4 TASK 5 - INTERACTION OF AGE BY LOOK TYPE BY DRAWING REALISM FOR NUMBER OF LOOKS MEASURE



ps<.001), and the second task produced greater levels of looking than the fourth and fifth tasks (Scheffe ps<.05). The mean number of looks were 8.3, 5.8, 4.9, 4.2 and 4.5 for the first, second, third, fourth and fifth tasks respectively. Unlike the results for the Number of Looks measure, there was no significant interaction between age and drawing order $(F(6,227)=1.78 \quad p>.05^{*})$.

A second 3 (age) x 5 (task) x 4 (look type) ANOVA was performed on the time each child spent looking at the model in front of them. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

The ANOVA showed significant main effects of age $(F(2,72)=25.08 \; p<.001)$ and task $(F(3,243)=11.02 \; p<.001^{*})$, and an interaction between these two factors $(F(7,243)=2.60 \; p<.05^{*})$. See Table 2.7 for details of the means. Follow-up analysis showed that, like the results for the Number of Looks measure, the 4- and 6-year-olds, although not significantly different from each other, both spent less time looking at the models than the 8-year-olds (Scheffe ps<.001). Task 1 again produced significantly lower levels of looking, but this time compared to all other tasks (Scheffe ps<.01). The interaction showed that the 8-year-olds were spending less time looking at Task 1 than Task 5 (Scheffe $F(7,243)=29.57 \quad p<.05$).

As detailed in Table 2.8, the ANOVA also showed a highly significant main effect of look type $(F(2,136)=300.59 \; p<.001^{*})$. Follow-up analysis showed that the 'beginning' looks were significantly higher, and the 'end' looks were significantly lower, than all other look types (Scheffe ps<.001). A significant interaction between age and look type $(F(4,136)=19.43 \; p<.001^{*})$ revealed that the 4-year-olds spent less time looking 'between' than the 8-year-olds (p<.05), while both 4- and 6-year-olds looked less 'within' than the 8-year-olds (Scheffe ps<.001). Therefore the 6-year-olds showed a tendency to spend more time looking 'between', while the 8-year-olds concentrated on looking 'within' drawing a separate element of the model.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 2.7 MEAN LOOKING TIME PER AGE AND TASK

AGE	N	TASK 1	TASK 2	TASK 3	TASK 4	TASK 5	MEAN TOTAL
4	19	0.13 (0.63)	0.18 (1.04)	0.15 (0.78)	0.19 (1.11)	0.16 (0.90)	**0.16 (0.89)**
6	30	0.16 (0.73)	0.22 (1.12)	0.23 (1.39)	0.26 (1.73)	0.21 (1.16)	**0.21 (1.22)**
8	26	0.26 (1.39)	0.34 (2.11)	0.35 (2.33)	0.33 (2.00)	0.38 (2.33)	**0.33 (2.03)**
MEAN TOTAL		**0.19 (0.92)**	**0.25 (1.42)**	**0.25 (1.50)**	**0.27 (1.61)**	**0.26 (1.46)**	

Untransformed means (seconds) are shown in parentheses.

TABLE 2.8 MEAN LOOKING TIME PER LOOK TYPE, AGE AND TASK

AGE/ TASK	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
4 YEARS	19	0.59 (3.25)	0.05 (0.29)	0.01 (0.02)	0.01 (0.01)	**0.16 (0.89)**
6 YEARS	30	0.65 (3.78)	0.13 (0.78)	0.06 (0.25)	0.02 (0.08)	**0.21 (1.22)**
8 YEARS	26	0.60 (3.20)	0.25 (1.25)	0.44 (3.57)	0.03 (0.11)	**0.33 (2.03)**
TASK 1	75	0.52 (2.51)	0.02 (0.07)	0.19 (1.04)	0.01 (0.04)	**0.19 (0.92)**
TASK 2	75	0.60 (3.19)	0.21 (1.04)	0.17 (1.40)	0.02 (0.07)	**0.25 (1.42)**
TASK 3	75	0.65 (3.64)	0.14 (0.76)	0.18 (1.52)	0.03 (0.08)	**0.25 (1.50)**
TASK 4	75	0.69 (4.21)	0.20 (1.16)	0.15 (0.98)	0.02 (0.11)	**0.27 (1.61)**
TASK 5	75	0.62 (3.52)	0.19 (0.82)	0.20 (1.46)	0.01 (0.04)	**0.26 (1.46)**
MEAN TOTAL		**0.62 (3.41)**	**0.15 (0.77)**	**0.18 (1.28)**	**0.02 (0.07)**	

Untransformed means (seconds) are shown in parentheses.

A significant interaction between task and look type was also found ($F(8,573)=6.25$ $p<.001^*$). Scheffe follow-up analysis showed that, like the results for the Number of Looks measure, the 'between' looks varied predictably between tasks, with Task 1 again producing less time looking than Tasks 2, 4 and 5 (Scheffe $ps<0.01$). It also showed Task 1 producing less 'beginning' looks than Task 4 (Scheffe $F(8,573)=45.25$ $p<.05^*$). See Table 2.8 and Figure 2.5 for details of this effect. An interaction between age, task and look type ($F(16,573)=2.30$ $p<.01^*$) seemed to result from the 8-year-olds varying their 'within' and 'between' looks predictably across tasks.

Summary of Main Findings

1: The children paid more attention towards the first model presented to them, irrespective of which model it was.

2: Task 1 produced low levels of looking.

3: The eight-year-olds paid more overall attention to the models than the other two age groups, and varied their looking behaviour across the complexities of the tasks.

4: The highest levels of attention occurred at the 'beginning' of the task, however the eight-year-olds continued to look 'within' drawing separate elements of the models. The six-year-olds showed a trend towards looking more 'between' drawing separate elements of the model.

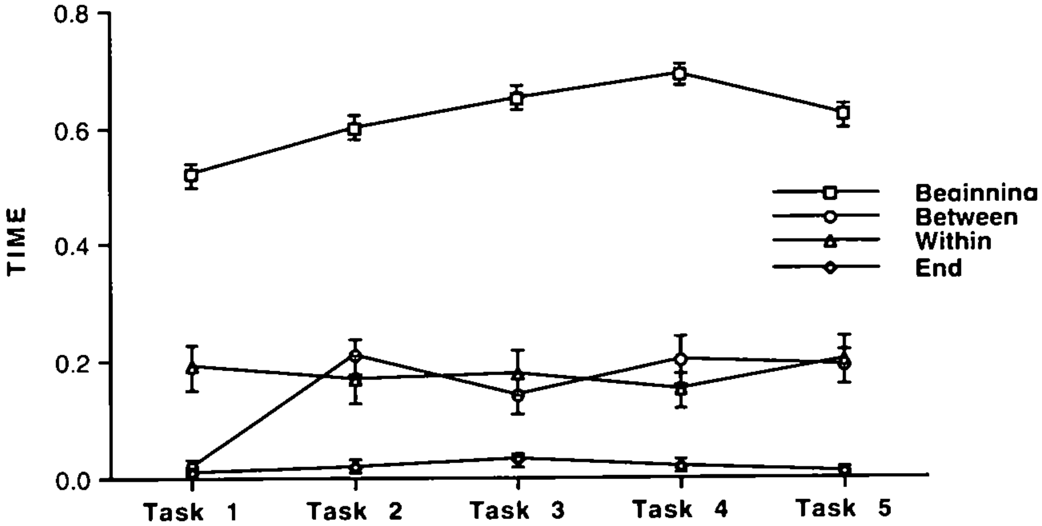
LOOKING TIME AND DRAWING REALISM

Comparison of intellectually and visually realistic drawers with regard to their time spent looking at the model, was again analysed separately for each task and with the 8-year-olds not included for Task 1 due to a lack of intellectually realistic drawers.

None of the five tasks showed a significant main effect of drawing realism ($ps>.05$). However, for Task 1 drawing realism interacted with look type ($F(2,96)=3.33$ $p<.05^*$), in that the intellectually realistic drawers looked at the model at the 'beginning' of the

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

FIGURE 2.5 INTERACTION OF LOOK TYPE BY TASK FOR LOOKING TIME MEASURE



task more than the visually realistic drawers. Although this is in opposition to the hypothesised direction, it is quite possible that the intellectually realistic child spent time looking for the hidden handle before they proceeded to draw the cup and handle. It must be noted however that this result only relates to the two younger age groups. See Table 2.9 and Figure 2.6 for further details.

Like the results for the Number of Looks measure, Task 5 showed a significant interaction between drawing realism, age and look type ($F(5,109)=2.65$ $p<.05$*). The visually realistic eight-year-olds showed comparable levels of 'beginning', 'between' and 'within' looking, all of which were significantly higher than their 'end' looks (Scheffe $ps<.001$). In contrast the intellectually realistic eight-year-olds showed no significant differences between the four look types (Scheffe $ps>.05$). See Table 2.10 and Figure 2.7 for further details.

Summary of Main Findings

1: Task 1 led to high levels of looking at the 'beginning' of the task for the four- and six-year-old intellectually realistic drawers.

2: Task 5 led to high levels of 'within' and 'between' looking for the eight-year-old visually realistic drawers.

NUMBER OF LOOKS AND LOOKING TIME

In order to assess the relationship between the two measures of attention, Pearson Product Moment partial correlations were performed on each child's Number of Looks and Looking Time, separately for each task. Partial correlations were used in order to control for any possible age effects. These showed positive correlations of $r = 0.83$, 0.83, 0.85, 0.69 and 0.80 (d.f.=72 $ps<.001$) for Tasks 1, 2, 3, 4 and 5 respectively.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 2.9 **MEAN LOOKING TIME PER DRAWING REALISM AND LOOK TYPE (TASK 1 - FOUR & SIX YEARS ONLY)**

REALISM	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
Visual	22	0.47 (2.11)	0.00 (0.00)	0.05 (0.27)	0.01 (0.04)	**0.13 (0.61)**
Intellectual	22	0.58 (2.90)	0.02 (0.13)	0.04 (0.22)	0.00 (0.02)	**0.16 (0.81)**
MEAN TOTAL		**0.52 (2.51)**	**0.02 (0.07)**	**0.06 (0.25)**	**0.01 (0.02)**	

Untransformed means (seconds) are shown in parentheses.

TABLE 2.10 **MEAN LOOKING TIME PER DRAWING REALISM, AGE AND LOOK TYPE (TASK 5)**

AGE	REAL-ISM †	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
4 Years	V.R.	1	0.51 (2.22)	0.31 (1.04)	0.00 (0.00)	0.00 (0.00)	
	I.R.	3	0.79 (5.49)	0.13 (0.51)	0.00 (0.00)	0.00 (0.00)	**0.22 (1.16)**
6 Years	V.R.	10	0.65 (3.67)	0.23 (0.90)	0.00 (0.00)	0.00 (0.00)	
	I.R.	13	0.65 (3.89)	0.15 (0.74)	0.04 (0.13)	0.00 (0.00)	**0.22 (1.17)**
8 Years	V.R.	20	0.59 (3.17)	0.44 (2.10)	0.67 (5.33)	0.02 (0.08)	
	I.R.	2	0.61 (3.09)	0.24 (1.01)	0.00 (0.00)	0.00 (0.00)	**0.32 (1.85)**
MEAN TOTAL			**0.63 (3.59)**	**0.29 (1.05)**	**0.28 (0.91)**	**0.01 (0.01)**	

† V.R. = Visual Realism I.R. = Intellectual Realism.
Untransformed means (seconds) are shown in parentheses.

FIGURE 2.6 TASK 1 FOUR- AND SIX-YEAR-OLDS - INTERACTION OF DRAWING REALISM BY LOOK TYPE FOR LOOKING TIME MEASURE

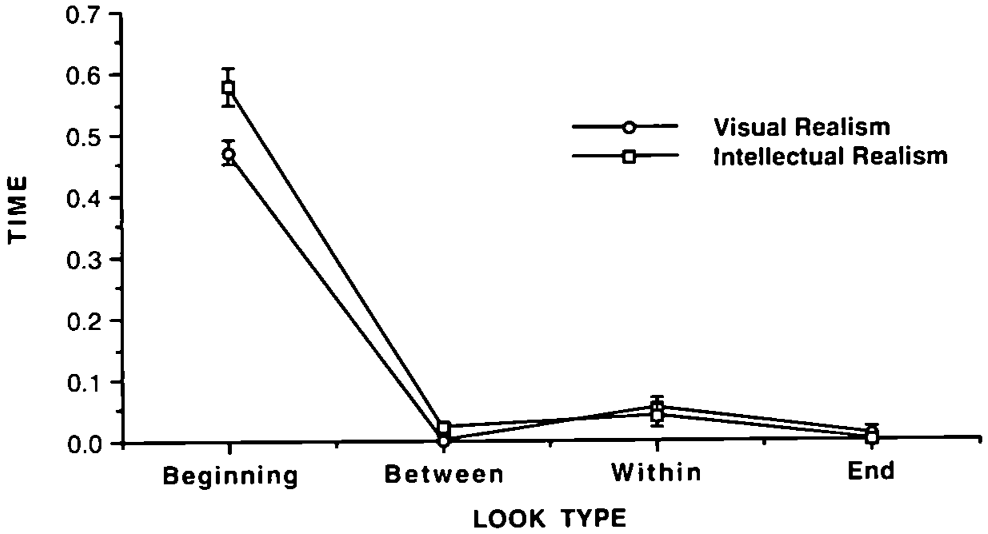
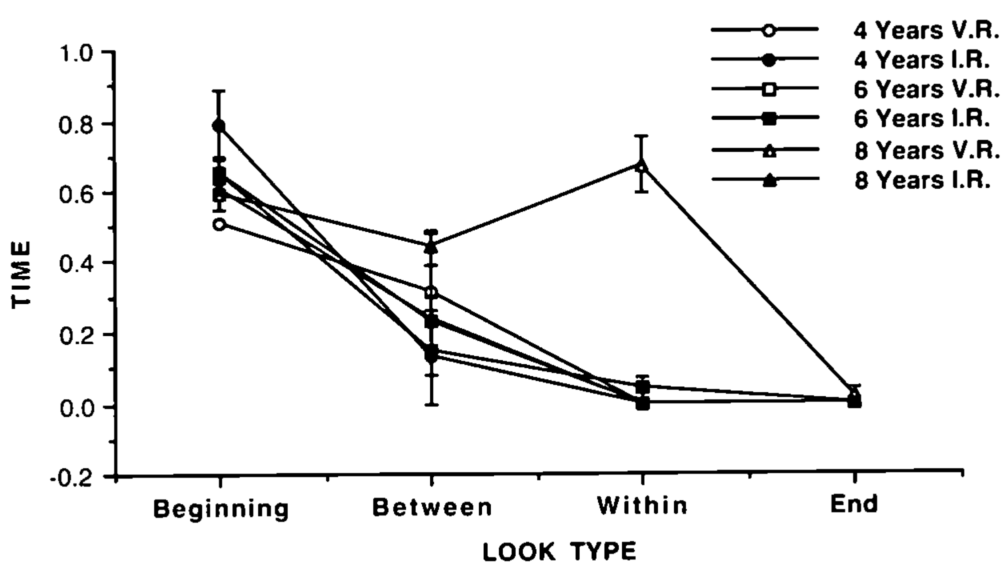


FIGURE 2.7 TASK 5 - INTERACTION OF DRAWING REALISM BY AGE AND LOOK TYPE FOR LOOKING TIME MEASURE



2.4 DISCUSSION

The eight-year-olds produced significantly higher levels of visual realism than both the four- and six-year-olds. It therefore seems that the transition from intellectual to visual realism, using standard procedures, did occur between six and eight years of age. However even with these standard procedures it was noted that the four- and six-year-olds performance could be enhanced through the order of presentation of the tasks. Prior exposure to a cup with a visible handle led to a reduction in intellectual realism on a subsequent task where the handle was hidden from view. This result replicated Davis & Bentley's (1984) findings. It therefore seems that the children noted the contrast between the orientations of the cups, and were concerned to demonstrate this in their drawings.

Around the same time that the transition from intellectual to visual realism was evident, the children significantly increased their attention towards the model they were being asked to draw. The younger children just tended to look at the model while the instructions were being given, and rarely looked again once they began to draw. The six-year-olds showed high levels of 'beginning' looks, and a tendency (although not significant) to look again 'between' drawing separate elements of the model. However it was not until eight years of age that there was an increase in 'within' looking, whereby the children continually checked what they were drawing against what they could see in front of them. This increase in attention with age agrees with the findings of Mitchelmore (1978) although in the present study it was evident in a younger subject sample. The older children therefore seemed to have an awareness of the need to keep looking, presumably in order to produce an accurate drawing. This was further demonstrated by the eight-year-olds increased attention towards the more complex tasks i.e. Tasks 4 and 5. The six-year-olds seem to be aware of the need to look more, but are unsure of the most efficient way of employing such a strategy.

Statistical comparison between the intellectually and visually realistic drawers with regard to their looking behaviour showed that for Task 1, greater looking time at the 'beginning' of the task was associated with intellectual realism for the four- and six-year-olds. This may suggest that the younger intellectually realistic children, instead of just looking and drawing what they could see of the model, initially continued to look while they took time to consider drawing the occluded features/objects. Possibly they were trying to decide whether the task required them to draw this feature or not. Alternatively the children may have been aware of the need to look, i.e. to be strategic in their attention towards the model, but were not aware of an effective strategy that would lead to an accurate drawing. In contrast the visually realistic eight-year-olds showed high levels of 'within' and 'between' looking with Task 5. This task proved to be quite difficult to draw, however it was evident that those eight-year-olds who did produce a visually realistic drawing, were the ones who were continually checking their drawing with the model in front of them. These children seem to be aware of the attentional strategy necessary to produce an accurate drawing. However it must be noted that as there was no prior control over classification of intellectual and visual realism, the subject numbers were quite low in many cases. Therefore further assessment is necessary before any firm conclusions can be drawn about the relationship between drawing realism and attentional strategies.

If a relationship could be demonstrated between drawing realism and attention it might provide a possible explanation for why explicit instructions have been shown to produce a beneficial effect on performance in the past (Barrett *et al.*, 1985). These instructions specifically ask the children to "look very carefully" and so may increase attentional behaviour, and in so doing may lead to the reported increase in visual realism.

Davis & Bentley (1984) used explicit instructions but still found low levels of visual realism in their condition where there was no prior exposure to a cup with its handle visible. If explicit instructions, increased attention and increased visual realism are associated with each other, it could be argued that the children would be visually realistic whether they had prior exposure or not. However their results were confounded by the fact that they assessed one age group ranging from four years eleven months to six years nine months. Barrett *et al.* (1985) stated that sensitivity to instructions only occurred after six and a half years of age. Therefore any effect found with the six-year-olds could have been masked by the data from the younger children. Davis (1983) also used explicit instructions and did provide data on the different age groups (although the analysis was performed on the group as a whole). This data seems to show that the six-year-olds were visually realistic in both prior and no prior exposure conditions, while the younger age groups were not.

It is therefore necessary to assess attentional strategies further, by measuring them under different instruction conditions, and manipulating the amount of attention possible through the use of different exposure durations. Due to the randomisation of the tasks there was no control over the number of subjects who received prior exposure to a cup with a visible handle, or not. Therefore the order effect needs to be replicated under controlled conditions, and to assess how this interacts with different instructions and exposure durations. This would also provide data with which to further assess the relationship between drawing realism and attention.

CHAPTER 3

STUDY 2
THE EFFECTS OF PRESENTATION ORDER, INSTRUCTIONS AND EXPOSURE TO THE DRAWING MODEL

3.1 INTRODUCTION

Study 1 provided a demonstration of how Luquet (1927) underestimated young children's ability to produce visually realistic drawings. Although in general it was the eight-year-olds who were consistently producing visually realistic drawings, the performance of the four- and six-year-olds could be improved by providing a contrast between orientations of the cup models. These results therefore replicated those of Davis (1983) and Davis & Bentley (1984) and show how the manipulation of certain task demands can have a dramatic effect on drawing ability.

Davis (1983) and Davis & Bentley (1984) demonstrated how providing a contrast either within a task, or between tasks, can aid a child's understanding of the task demands. Davis placed a cup contrasting in orientation (handle visible) beside the cup to be drawn (target cup) which had its handle turned out of view. This situation produced a higher incidence of visually realistic drawings than just the target cup placed on its own. Davis & Bentley demonstrated this contrast effect between tasks. If the child was asked to draw a cup with its handle visible before drawing a cup with its handle hidden, the child was more likely to produce a visually realistic drawing of the second cup. If the reverse order was presented, the child was more likely to produce an intellectually realistic drawing of the cup with its handle hidden. These studies concluded that providing a contrast led to a realisation by the children that the task demanded them to portray the orientation of the cup in their drawings.

Barrett, Beaumont & Jennett (1985) found that greater understanding of the task demands can also be achieved by increasing the 'explicitness' of the instructions. These seem to prompt the younger children to produce visually realistic drawings while the standard instructions do not. Closer inspection of the instructions used by Barrett *et al.* shows that they asked the child to "look very carefully" at the model. It could be that these instructions prompt the child to pay more attention to the model in front of them, and therefore leads to an increase in visual realism. However little research has been conducted into attentional processes in children's drawings, and where attention has been manipulated it has not led to any significant change in performance (Nieland & Cox, cited in Cox, 1991).

Mitchelmore (1978) varied the exposure to the drawing model by either leaving the model in front of the child while they drew it, or removing it, but found no effect of this manipulation. However there were no details of how attention was assessed, and there were methodological problems with this study, in particular the short exposure condition was only one second! Klaue (1992) improved on this by allowing the children to look at a partial occlusion ball model while the instructions were being given and then removed it. However again this condition did not lead to any significant differences in the proportion of visually realistic drawings produced by children aged five to eleven years, compared to the model remaining visible throughout. However it must be noted that the instructions used in this experiment were *very* inexplicit, "Draw exactly what you see". They were also very short, and therefore the model would still have only remained in front of the child for a few seconds in the hidden model condition.

In Study 1 a more direct assessment of attentional behaviour was reported. The number of looks and the time spent looking at the model was recorded. There was a significant increase in attention between six and eight years of age. In agreement with Mitchelmore, the younger children tended only to look once at the beginning of the task, while the older children looked more while they were drawing. However here the age differences were between four and eight years, while for Mitchelmore the difference was between seven and fourteen years. This reported increase in attentional behaviour coincided with a significant increase in visual realism. However due to low subject numbers further assessment was necessary in order to draw any firm conclusions.

If a relationship could be shown, it may provide a possible explanation of why explicit instructions, which prompt attention to the model, lead to increased performance. Although Davis (1983) and Davis & Bentley (1984) used explicit instructions they still reported low levels of visual realism in the single cup task and when the hidden handle task was presented first. If explicit instructions increase attention the children should be capable of being visually realistic irrespective of prior exposure to a cup with its handle visible. However in both these studies analyses were performed on the group as a whole. Barrett *et al.* showed that sensitivity to instructions only occurred after six years and six months, therefore any effects found with the older children could have been masked by a lack of difference shown by the younger children. Beal & Arnold (1990) asked children to draw a cup with its handle hidden under standard or explicit instructions, and found that the explicit instructions increased visual realism in five-year-olds. Davis does provide data separately for the different ages (although analysis was performed on the sample as a whole) and this shows the six-year-olds being visually realistic in both the paired cup and the single cup conditions.

A replication of Davis & Bentley's contrast effect was detailed in Study 1, Chapter 2. However due to the randomised presentation of the tasks, the number of children who were presented with either prior exposure to the handle or not, could not be controlled for. There was therefore a need to replicate this effect further under controlled conditions, separately for different age groups. In order to clarify the effect of instructions, both standard and explicit instructions (stressing looking) needed to be presented under both presentation order conditions.

Study 1 stated that the eight-year-olds, who showed the highest levels of visual realism, were continuing to pay attention to the model while they drew. If removing the possibility of continued attention leads to a deterioration in performance this would provide a further measure of the importance of attention in a drawing task. Although Mitchelmore (1978) and Klaue (1992) found no effect of short and continued exposure conditions, the methodological problems with these studies make it difficult to draw any firm conclusions from their results.

Children aged four, six and eight years of age were therefore divided into eight conditions, with either explicit or standard instructions, continued or short exposure to the model, and presented with either a cup with its handle visible followed by a cup with its handle hidden, or the reverse task order. The children were videoed in order to assess their attention towards the model under the varying conditions.

The hypotheses for the drawing data were that:-

1: Visual realism on the cup with its handle hidden would increase with age.

2: Prior exposure to the cup with its handle visible would be necessary to produce visual realism on the cup with its handle hidden, when presented with the standard instructions.

3: Visual realism without prior exposure to the handle would occur when presented with the explicit instructions.

4: Continued exposure to the model would be necessary to produce visual realism.

The hypotheses for the attentional data were that:-

1: Attention towards the model would increase with age.

2: Explicit instructions would increase attention towards the model.

3: Short exposure to the model would decrease attention.

4: The younger children would look at the model at the beginning of the task while the older children would continue to look while they drew.

5: Visual realism would be associated with increased attention towards the model.

3.2 METHOD

3.2.1 SUBJECTS

Three hundred and four children were randomly selected by the experimenter from the relevant classes in four Plymouth schools. There were eighty children with a mean age of 4 years 4 months (range 3:7 to 5:0, standard deviation 0:4 months), one hundred and four children with a mean age of 6 years 2 months (range 5:6 to 6:11, standard deviation 0:4 months) and one hundred and twenty children with a mean age of 8 years 1 month (range 7:3 to 9:2, standard deviation 0:7 months). Each age group was randomly divided into eight, so that there were ten 4-year-olds, thirteen 6-year-olds and fifteen 8-year-olds in each of the eight conditions. There were one hundred and fifty-nine males, and one hundred and forty-five females.

3.2.3 DESIGN

A 3 (age) x 2 (instruction) x 2 (exposure) x 2 (drawing order) x 2 (task) design was conducted, with independent groups on the first four factors and two repeated measures on the last. The independent variables were age, instruction, exposure, drawing order and task. The dependent variables were, for the drawing data, inclusion or non-inclusion of the handle, and for the video data, the amount of attention the child paid towards the model placed in front of them.

3.2.3 MATERIALS

One plain white coffee mug, with a handle, measuring 9.5 cms. high and 8 cms. wide was used for the drawing model. This was placed on three separate inverted boxes measuring 15 cms., 26 cms. and 32 cms. high for the 4-, 6- and 8-year-olds respectively, in order to ensure presentation at eye-level. Plain A5 paper and a black pencil were given to the children to draw with.

3.2.4 PROCEDURE

Each child was tested individually by the same female experimenter in a private room at their school. Once rapport had been established, the child was asked to sit squarely at a table where an inverted box had been placed directly in front of them. The height of the box varied with the age group in order to ensure that the model was placed at approximate eye level. The centre of the box was at a distance of 60 cms. from the child.

A video camera was angled to observe the child's direction of gaze and the drawing area in front of them. The experimenter tried not to draw too much attention towards the camera's presence in the room, by keeping contact with it to a minimum.

The child was given a plain piece of paper and a pencil. The experimenter then stated the instructions appropriate for the condition which the child had been assigned to. There were eight conditions in all, two instructions x two exposure durations x two task orders.

Standard Instructions Continuous Exposure (SC)

To begin with the experimenter stated "I am going to ask you to do two drawings for me. Each time I want you to draw exactly what you can see from where you are sitting". A cup was then placed in front of the child. The experimenter said "Here is a cup. Please can you draw exactly what you can see from where you are sitting". Once completed the child was then given another plain piece of paper, the cup was rotated and the same instructions repeated. The child either saw a cup with its handle visible followed by a cup with its handle hidden at the back [Handle, No handle (HN)], or the reverse order [No handle, Handle (NH)].

Explicit Instructions Continuous Exposure (EC)

To begin with the experimenter stated "I am going to ask you to do two drawings for me. Each time I want you to look very carefully so that you can draw exactly what you can see from where you are sitting". A cup was then placed in front of the child. The experimenter said "Here is a cup. Please look very carefully at it so that you can draw exactly what you can see from where you are sitting". Once completed the child was then given another plain piece of paper, the cup was rotated and the same instructions repeated. The child either saw a cup with its handle visible followed by a cup with its handle hidden at the back (HN), or the reverse order (NH).

Standard Instructions Short Exposure (SC)

The same procedure as the Standard Continuous condition was employed however, after being asked to draw each cup the following statement was added "I am now going to remove the cup, please draw it". The cup was then removed. The child therefore only had exposure to the cup while the instructions were being given. The child either saw a cup with its handle visible followed by a cup with its handle hidden at the back (HN), or the reverse order (NH).

Explicit Instructions Short Exposure (ES)

The same procedure as the Explicit Continuous condition was employed however, after being asked to draw each cup the following statement was added "I am now going to remove the cup, please draw it". The cup was then removed. The child therefore only had exposure to the cup while the instructions were being given. The child either saw a cup with its handle visible followed by a cup with its handle hidden at the back (HN), or the reverse order (NH).

If the child was unsure of what (s)he was required to do, the instructions were repeated. Each child was given as much time as they required to complete each drawing. Each child was praised for their drawings and thanked for their help.

3.2.5 SCORING

DRAWING DATA

Each child's two drawings were classified into one of five categories i.e. inclusion of handle, non-inclusion of handle, handle only, scribbled, or no drawing.

1: Including the handle in their drawing, when the handle had been hidden from view was classified as intellectually realistic, while non-inclusion was classified as visually realistic.

2: Including the visible handle in their drawing was classified as visually realistic, while non-inclusion was classified as an omission.

3: Drawings without any recognisable features were classified as scribbled.

4: The 'no drawing' category referred to those children in the short exposure conditions who were unable to draw anything once the cup had been removed.

In order to establish inter-judge reliability, 10% of the subjects were randomly selected and their drawings were re-classified by a second independent judge. Classification showed an 97% agreement. The Kappa statistic [for assessment of categorical data (Siegel & Castellan, 1988)] showed a strong agreement between judges, which was found to be significantly different from zero ($K=0.93$, $Z=5.22$ $p<.001$). The classifications of the first judge were used in the subsequent analyses.

ATTENTIONAL DATA

Each child's attention towards the model in front of them was scored in two ways. Firstly the number of looks and secondly the time spent looking at the model. These two measures were divided into the Number of Looks or Looking Time at the 'beginning' of the task before drawing commenced; 'between' drawing separate elements of the model; 'within' drawing a particular element and at the 'end' of the task after the drawing had been completed.

In order to establish intra-observer reliability, 10% of the subjects were randomly selected and their attention was re-assessed. Pearson Product Moment correlations were used to compare the relationship between the first and second assessments, separately for each attentional measure. There were a very high number of zero scores due to a high proportion of subjects only looking at the 'beginning' of the task. It was felt that inclusion of these scores would adversely affect the analyses. The correlation on the remaining data showed very strong relationships for the Number of Looks and Looking Time measures ($r=0.82$ and 0.93 respectively, $d.f.=93$ $ps<.001$).

Due to the zero scores being omitted from the correlation, intra-observer reliability of classification of attention into the four look types was assessed using the Phi Coefficient [for use with nominal data (Siegel & Castellan, 1988)]. There was a 93% agreement overall, which represented highly significant associations for the 'beginning', 'between', 'within' and 'end' look types (rø = 1.0, 0.77, 0.86 and 0.65 respectively). These scores were shown to be significantly different from zero (X^2 = 15.00, 13.27, 17.24 ps<.001 and 8.78 p<.01, respectively).

The reliability assessment of the attentional data was conducted on an intra-observer basis due to the scoring of the children's attention being a lengthy and complex procedure.

3.2.6 DATA ANALYSIS

DRAWING DATA

The proportions of children producing intellectually and visually realistic drawings were analysed using Log-Linear Modelling. This allows analysis of frequency data from two or more independent groups, to be assessed across two or more discrete categorical variables, therefore incorporating interaction effects. Full details of this procedure are given in Appendix C.

Where more than twenty percent of the expected cell frequencies were less than five, the Chi-Square test for independent samples was used. This allows for analysis of just one categorical variable at any one time. Where the observed set of frequencies formed a 2 x 2 contingency table, the Yates correction for continuity was applied (Siegel & Castellan, 1988). If any of these expected cell frequencies were less than five, the Fisher Exact Probability test was used. Single Sample Goodness of Fit tests were used, where data from one group was assessed across one categorical variable (Siegel, 1956).

ATTENTIONAL DATA

Analysis of Variance (ANOVA) was used to assess the amount of attention paid towards the drawing model. Where the assumption of homogeneity of variance between conditions was not met, transformations were performed on the raw data according to the criteria detailed in Howell (1987). Significant differences were assessed using Scheffe's method of multiple comparison of means (See Appendix A for full details).

3.3 RESULTS

3.3.1 DRAWING DATA

The number of children in each age group and condition (combining task orders) producing the five types of drawings are detailed in Table 3.1. The three 6-year-olds in the 'No Drawing' condition were eliminated from all analyses (drawing and attention). Data was therefore available for 301 children.

Where the analysis was computed using Log-Linear Modelling, full tables showing the Likelihood Ratio for Chi-square Change for each model tested, and the standardised residuals (i.e. the difference between observed and the expected frequencies based on the selected model) are detailed in Appendix D. Full details of the Log-Linear Modelling procedure are given in Appendix C.

AGE EFFECTS

Chi-Square and Fisher Exact Probability tests were used to assess age related changes in the proportion of children producing drawings with or without handles attached to the body of the cup.

Handle Visible The four-year-olds produced lower levels of visual realism in favour of omitting the visible handle, compared to the 6- and 8-year-olds in all but the ES condition. Here the four-year-olds produced comparable levels of visual realism to the 6-year-olds and therefore only the 4- and 8-year-olds differed significantly (Fisher Exact Test ps<.05).

Handle Hidden Both the standard instruction conditions produced no significant increases with age (Chi-Square ps>.05). All ages produced fairly high levels of visual realism. Both the explicit instruction conditions did however show significant differences. The EC condition showed the 4-year-olds producing greater proportions of intellectual realism while the 6- and 8-year-olds produced greater proportions of visual realism (Fisher Exact Test ps<.01).

TABLE 3.1 FREQUENCY OF DRAWINGS IN EACH CONDITION

CONDITION	AGE	N	HANDLE	NO HANDLE	SCRIBBLE	HANDLE ONLY	NO DRAWING
			HANDLE VISIBLE				
SC	4	20	9	8	2	1	0
	6	26	25	0	0	1	0
	8	30	30	0	0	0	0
EC	4	20	9	4	7	0	0
	6	26	25	1	0	0	0
	8	30	30	0	0	0	0
SS	4	20	10	9	1	0	0
	6	26	23	1	0	0	2
	8	30	30	0	0	0	0
ES	4	20	15	4	1	0	0
	6	26	25	0	0	0	1
	8	30	30	0	0	0	0
			HANDLE HIDDEN				
SC	4	20	6	12	2	0	0
	6	26	11	15	0	0	0
	8	30	6	24	0	0	0
EC	4	20	8	5	7	0	0
	6	26	4	22	0	0	0
	8	30	3	27	0	0	0
SS	4	20	7	12	1	0	0
	6	26	11	13	0	0	2
	8	30	10	20	0	0	0
ES	4	20	15	4	1	0	0
	6	26	15	10	0	0	1
	8	30	8	22	0	0	0

The 4-year-olds seem to show reduced performance in this condition, and it can be seen from Table 3.1 that a fairly high proportion of drawings were classified as 'scribbled' in this condition, as opposed to the other three. The ES condition showed the 4- and 6-year-olds producing greater proportions of intellectual realism than the 8-year-olds (X^2=10.75 d.f.=1 p<.01 and 4.93 d.f.=1 p<.05 respectively).

FOUR-YEAR-OLDS

Table 3.2 details the proportion of 4-year-olds for each task order and condition, producing drawings with or without a handle, for both the drawing tasks.

Handle Hidden Log-Linear Modelling was used to analyse the frequency of drawings featuring the hidden handle or not. Separating out the observed frequencies for instructions, exposure and task order resulted in more than the required 20% of expected cell frequencies being below five. The observed frequencies were therefore initially combined across instructions, then across exposure and finally across order.

Backward elimination of this first Log-Linear Model resulted in no factors being sufficient to explain the observed frequencies i.e. task order, exposure, drawing realism or any interactions between these factors (ps>.05). Backward elimination of the other two Log-Linear Models both resulted in an interaction between instructions and drawing realism being sufficient to explain the observed frequencies. The Likelihood Ratio for Chi-Square Change for removal of this interaction was significant (X^2=9.53 d.f.=1 p<.01). Table 3.3 details the observed frequencies and the summary of the follow-up analysis for this interaction.

This shows that the four-year-olds were producing increased levels of what appears to be visual realism with the standard instructions, and increased levels of intellectual realism with the explicit instructions. This is denoted by the algebraic signs of the lambda values and the significant Z tests for these values. This result was therefore in opposition to previous research and the hypothesis that the explicit instructions would increase visual realism. This therefore questions whether these children can be

TABLE 3.2 FOUR-YEAR-OLD DRAWING DATA

		HANDLE HIDDEN		HANDLE VISIBLE	
CONDITION	ORDER	HANDLE	NO HANDLE	NO HANDLE	HANDLE
SC	HN	3	6	5	4
	NH	3	6	3	5
EC	HN	2	2	1	3
	NH	6	3	3	6
SS	HN	7	3	1	9
	NH	0	9	8	1
ES	HN	7	2	2	7
	NH	8	2	2	8

TABLE 3.3 OBSERVED FREQUENCIES AND SUMMARY FOLLOW-UP ANALYSIS FOR THE INSTRUCTION BY DRAWING REALISM INTERACTION

	VISUAL REALISM			INTELLECTUAL REALISM		
Instuc- tions	Observed Frequency	Lambda	Z Tests*	Observed Frequency	Lambda	Z Tests*
Standard	24	+0.39	+2.98	13	-0.39	-2.98
Explicit	9	-0.39	-2.98	23	+0.39	+2.98
TOTAL	33	0.00	0.00	36	0.00	0.00

* Z scores greater than or equal to 1.96 (+ or -) are significant at p<.05.

classified as 'visually' or 'intellectually realistic' in the same way as the older children.

Handle Visible Log-Linear Modelling was used to analyse the frequency of drawings featuring the visible handle or not. Separating out the observed frequencies for instructions, exposure and task order was not possible, therefore the observed frequencies were initially combined across exposure and then combined across order. This was done in order to preserve the effect of instructions which had proved necessary to explain the data for the Handle Hidden task.

Backward elimination of these two Log-Linear models resulted in only the effect of drawing realism being sufficient to explain the observed frequencies in each case. The Likelihood Ratio for Chi-Square Change for removal of this factor was significant (X^2=4.82 d.f.=1 $p<.05$). As can be seen in Table 3.4 there was a greater proportion of visually realistic drawings overall. As the effect of instruction proved insignificant, the data was further combined across this factor in order to assess the relationship between exposure and order.

Backward elimination resulted in a model that contained the three-way interaction between exposure, task order and drawing realism. The Likelihood Ratio for Chi-Square Change for removal of this interaction was significant (X^2=4.44 d.f.=1 $p<.05$). Table 3.4 details the observed frequencies and summary of the follow-up analysis for this interaction.

There were no significant differences in the proportion of visually realistic and omission drawings in both the continuous exposure conditions (ps>.05). However the children in the short exposure HN condition included more handles in their drawings (visual realism), while more children in the short exposure NH condition omitted the visible handle (denoted by the positive significant results). This was therefore consistent with the children producing a 'seemingly' visually realistic drawing on the first task and then producing exactly the same drawing for the second task, irrespective of the changed orientation of the cup.

TABLE 3.4 OBSERVED FREQUENCIES AND SUMMARY FOLLOW-UP ANALYSIS FOR THE EXPOSURE BY TASK ORDER BY DRAWING REALISM INTERACTION

	VISUAL REALISM			OMISSION		
Exposure Order	Observed Frequency	Lambda	Z Tests*	Observed Frequency	Lambda	Z Tests*
Continuous						
HN	7	-0.18	-1.33	6	+0.24	+1.77
NH	11	-0.01	-0.07	6	-0.03	-0.22
Short						
HN	16	+0.52	+3.84	3	-0.57	-4.21
NH	9	-0.33	-2.44	10	+0.36	+2.66
TOTAL	43	0.00	0.00	25	0.00	0.00

* Z scores greater than or equal to 1.96 (+ or -) are significant at $p<.05$.

TABLE 3.5 FREQUENCY OF IDENTICAL AND NON-IDENTICAL DRAWINGS

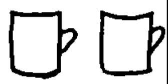
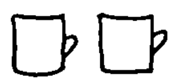
CONDITION	IDENTICAL			NON-IDENTICAL		
HN ORDER			TOTAL			TOTAL
SC	2	4	6	2	1	3
EC	2	1	3	1	0	1
SS	7	1	8	2	0	2
ES	7	2	9	0	0	0
TOTAL	18	8	26	5	1	6
NH ORDER			TOTAL			TOTAL
SC	3	3	6	2	0	2
EC	2	5	7	1	1	2
SS	8	0	8	1	0	1
ES	2	8	10	0	0	0
TOTAL	15	16	31	4	1	5

Table 3.5 details the pattern of identical drawings for each condition and task order. This shows that significantly more 4-year-olds produced two identical drawings. When presented with the HN order they tended to produce two drawings with handles. The NH order overall, showed consistent frequencies for identical drawings with or without handles. However the two short exposure conditions showed a marked difference. With standard instructions (SS) the 4-year-olds were more likely to produce two identical pictures without handles, while with the explicit instructions (ES) they produced two identical pictures with handles (Fisher Exact Test $p<.01$).

<u>Summary of Main Findings</u>

1: The 4-year-olds were systematic in their drawing responses i.e. they tended to produce two identical drawings based on the first model they saw and irrespective of the orientation of the second.

2: They could not be classified as 'intellectually' or 'visually realistic' in the same way as the older children.

<u>SIX-YEAR-OLDS</u>

Table 3.6 details the proportion of 6-year-olds for each task order and condition, producing intellectually or visually realistic drawings in the Handle Hidden task, and the proportion of visually realistic and omission drawings for the Handle Visible task.

<u>Handle Visible</u> The 6-year-olds had no problem with producing a visually realistic drawing of a cup with its handle visible.

<u>Handle Hidden</u> A Log-Linear Model was used to analyse the frequency of intellectually and visually realistic drawers in this task. Backward elimination resulted in a model that contained interactions between task order and drawing realism, and between instructions, exposure and drawing realism. The Likelihood Ratio for Chi-Square Change for removal of these interactions were significant (X^2=4.65 and 5.17 respectively, d.f.=1 $ps<.01$). Tables 3.7 and 3.8 detail the observed frequencies and

TABLE 3.6 SIX-YEAR-OLD DRAWING DATA

		HANDLE HIDDEN		HANDLE VISIBLE	
CONDITION	ORDER	Intellectual Realism	Visual Realism	Omission	Visual Realism
SC	HN	3	10	0	13
	NH	8	5	0	12
EC	HN	2	11	0	13
	NH	2	11	1	12
SS	HN	4	8	1	11
	NH	7	5	0	12
ES	HN	6	6	0	12
	NH	9	4	0	13

TABLE 3.7 OBSERVED FREQUENCIES AND SUMMARY FOLLOW-UP ANALYSIS FOR THE TASK ORDER BY DRAWING REALISM INTERACTION

	VISUAL REALISM			INTELLECTUAL REALISM		
Order	Observed Frequency	Lambda	Z Tests*	Observed Frequency	Lambda	Z Tests*
HN	35	+0.22	+2.11	15	-0.22	-2.11
NH	25	-0.22	-2.11	26	+0.22	+2.11
TOTAL	60	0.00	0.00	41	0.00	0.00

* Z scores greater than or equal to 1.96 (+ or -) are significant at $p<.05$.

TABLE 3.8 OBSERVED FREQUENCIES AND SUMMARY FOLLOW-UP ANALYSIS FOR THE INSTRUCTION BY EXPOSURE BY DRAWING REALISM INTERACTION

	VISUAL REALISM			INTELLECTUAL REALISM		
Instructions Exposure	Observed Frequency	Lambda	Z Tests*	Observed Frequency	Lambda	Z Tests*
Standard						
Continuous	15	-0.26	-2.16	11	+0.15	+1.25
Short	13	-0.22	-1.83	11	+0.33	+2.75
Explicit						
Continuous	22	+0.54	+4.50	4	-0.44	-3.67
Short	10	-0.06	-0.50	5	-0.04	-0.33
TOTAL	60	0.00	0.00	31	0.00	0.00

* Z scores greater than or equal to 1.96 (+ or -) are significant at $p<.05$.

summary of the follow-up analysis for these interactions.

Table 3.7 details the overall order effect. Inspection of the algebraic signs of the lambda values shows that the HN order led to increased visual realism, while the NH order led to increased intellectual realism. Therefore prior exposure to the cup with its handle visible led to increased visual realism on a subsequent drawing of a cup with its handle hidden from view.

Inspection of the algebraic signs of the lambda values in Table 3.8, shows that for the visually realistic drawings, although both the continuous exposure conditions showed significant Z scores, the number of visually realistic drawings was particularly high in the EC condition. Consequently this condition showed a significantly low number of intellectually realistic drawings (denoted by the significant negative value). Although there was an overall order effect, looking at the frequencies in Table 3.6 this was not the case with the EC condition, and this seems to have led to the increased frequency of visually realistic drawings in this condition overall. Therefore explicit instructions with continuous exposure to the model seems to have produced visual realism without prior exposure to a handle (NH). Prior exposure (HN) seems to have been necessary in order to produce visual realism with standard instructions and continuous exposure.

Summary of Main Findings

1: For the Hidden Handle Task greater levels of visual realism were produced when this task was presented second, after the Handle Visible task.

2: The Explicit Continuous condition led to increased levels of visual realism on the Handle Hidden task, as prior exposure to the model was not necessary.

EIGHT-YEAR-OLDS

Table 3.9 details the proportion of 8-year-olds for each task order and condition, producing intellectually or visually realistic drawings in the Handle Hidden task, and the proportion of visually realistic and omission drawings for the Handle Visible task.

TABLE 3.9 EIGHT-YEAR-OLD DRAWING DATA

		HANDLE HIDDEN		HANDLE VISIBLE	
CONDITION	ORDER	Intellectual Realism	Visual Realism	Omission	Visual Realism
SC	HN	1	14	0	15
	NH	5	10	0	15
EC	HN	0	15	0	15
	NH	3	12	0	15
SS	HN	3	12	0	15
	NH	7	8	0	15
ES	HN	2	13	0	15
	NH	6	9	0	15

Handle Visible Every child produced a visually realistic drawing.

Handle Hidden Log-Linear Modelling was used to analyse the frequency of intellectually and visually realistic drawings. It was not possible to separate out the observed frequencies for each instruction, task order and exposure. Therefore the observed frequencies were initially combined across instructions, then across order and finally across exposure. Backward elimination of these three Log-Linear Models resulted in two interactions explaining the observed frequencies i.e. an interaction between exposure and drawing realism and between task order and drawing realism. The Likelihood Ratio for Chi-Square Change for removal of these interactions were significant (X^2=3.93 d.f.=1 p<.05 and 11.26 d.f.=1 p<.001 respectively). Tables 3.10 and 3.11 detail the observed frequencies and summary of the follow-up analysis for these interactions.

Follow-up analysis of the exposure by drawing realism interaction just failed to reach significance. However inspection of the algebraic signs of the lambda values detailed in Table 3.10, reveals that the short exposure conditions seem to have reduced levels of visual realism and subsequently increased levels of intellectual realism. It is possible that if the task had been more complex, this effect might have shown significant results at follow-up.

Table 3.11 details the task order by drawing realism interaction. This, like the 6-year-olds, shows how the order of presentation affected performance levels. Prior exposure to the cup with its handle visible (HN) led to increased visual realism on the subsequent drawing of the cup with its handle hidden from view.

Summary of Main Findings

1: Short exposure to the model showed a trend towards reducing levels of visual realism.

2: The task seems to have been too simple for this age group.

3: For the Hidden Handle task greater levels of visual realism were noted when this task was presented second, after the Handle Visible task.

TABLE 3.10 OBSERVED FREQUENCIES AND SUMMARY FOLLOW-UP ANALYSIS OF THE EXPOSURE BY DRAWING REALISM INTERACTION

	VISUAL REALISM			INTELLECTUAL REALISM		
Exposure	Observed Frequency	Lambda	Z Tests*	Observed Frequency	Lambda	Z Tests*
Continuous	51	+0.22	+1.92	9	-0.22	-1.92
Short	42	-0.22	-1.92	18	+0.22	+1.92
TOTAL	93	0.00	0.00	27	0.00	0.00

* Z scores greater than or equal to 1.96 (+ or -) are significant at $p<.05$.

TABLE 3.11 OBSERVED FREQUENCIES AND SUMMARY FOLLOW-UP ANALYSIS OF THE TASK ORDER BY DRAWING REALISM INTERACTION

	VISUAL REALISM			INTELLECTUAL REALISM		
Task Order	Observed Frequency	Lambda	Z Tests*	Observed Frequency	Lambda	Z Tests*
HN	54	+0.40	+3.15	39	-0.39	-3.07
NH	6	-0.40	-3.15	21	+0.39	+3.07
TOTAL	93	0.00	0.00	27	0.00	0.00

* Z scores greater than or equal to 1.96 (+ or -) are significant at $p<.05$.

3.3.2 ATTENTIONAL DATA

The following sections detail the main findings of the attentional analysis. The full analysis of variance summary tables and details of the subsidiary results are given in Appendix E. Due to problems associated with the video equipment data was unavailable for three 8-year-olds. Analysis was therefore performed on the data from the remaining 298 children.

3.3.2.1 NUMBER OF LOOKS

CONTINUOUS AND SHORT EXPOSURES

As the short exposure only allowed for looking at the 'beginning' of the task, there was no factor of look type for these two conditions. Therefore in order to compare the continuous and short exposures a 3 (age) x 2 (instruction) x 2 (exposure) x 2 (task order) x 2 (drawing order) analysis of variance was performed on the total number of times each child looked at the model in front to them. The four look types were therefore combined in the continuous exposure conditions. Due to unequal variances and the standard deviations being proportional to the mean squares, a reciprocal transformation was performed on the data.

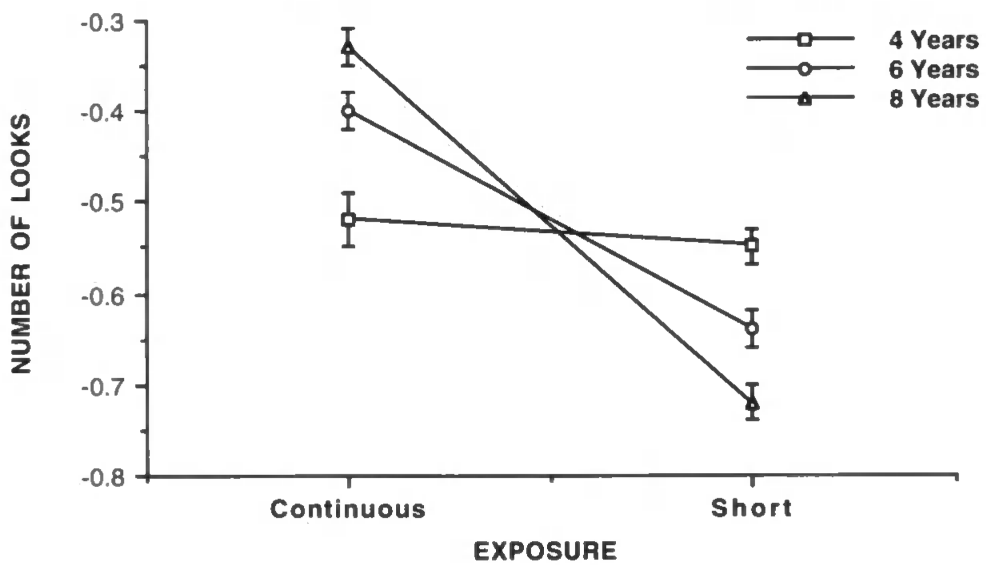
The analysis showed that there were no significant main effects for age ($F(2,274)=0.14$ $p>.05$) or instruction ($F(1,274)=0.05$ $p>.05$). There was however a highly significant main effect of exposure ($F(1,274)=83.45$ $p<.001$) and an interaction between exposure and age ($F(2,274)=18.75$ $p<.001$). Predictably a greater number of looks occurred with the continuous exposure. However, although the 6- and 8-year-olds showed this pattern of behaviour (Scheffe $ps<.01$), the 4-year-olds showed no significant difference in their looking patterns over the two exposures (Scheffe $F(2,274)=0.43$ $p>.05$). See Table 3.12 and Figure 3.1 for details of this interaction effect. This analysis of variance also showed a highly significant main effect of drawing order ($F(1,274)=96.08$ $p<.001$). More looking occurred on the first task the child was asked to draw irrespective of which task this was (mean number of looks = 3.47 and 2.41 respectively).

TABLE 3.12 MEAN NUMBER OF LOOKS PER AGE AND EXPOSURE

AGE	N	CONTINUOUS	SHORT	MEAN TOTAL*
4 YEARS	80	0.52 (2.89)	0.55 (2.15)	**0.53 (2.52)**
6 YEARS	101	0.40 (3.54)	0.64 (1.84)	**0.52 (2.69)**
8 YEARS	117	0.33 (5.26)	0.72 (1.63)	**0.53 (3.45)**
MEAN TOTAL*		**0.42 (3.90)**	**0.63 (1.87)**	

*Note: Due to reciprocal transformation the short exposure shows the lowest mean. Untransformed means (number of looks) are shown in parentheses.

FIGURE 3.1 INTERACTION OF AGE BY EXPOSURE FOR NUMBER OF LOOKS MEASURE (CONTINUOUS AND SHORT EXPOSURES)



Summary of Main Findings

1: More looking occurred with the continuous exposure.

2: The four-year-olds, as opposed to the other two age groups, showed no significant difference in their total looking between the short and continuous exposure durations.

3: More looking occurred on the first task the children were asked to draw irrespective of which task this was.

NUMBER OF LOOKS AND DRAWING REALISM

When comparing intellectually and visually realistic drawers with the Hidden Handle task, with regard to their number of looks, it was not possible to distinguish between task orders due to a lack of intellectually realistic drawers in some order conditions. However a 3 (age) x 2 (instruction) x 2 (exposure) x 2 (drawing realism) analysis of variance was performed. Due to unequal variances and the standard deviations being proportional to the mean squares, a reciprocal transformation was performed.

This analysis revealed no significant difference in looking behaviour between intellectually and visually realistic drawers ($F(1,262)=0.58$ $p>.05$), or any interactions between this factor and any of the independent variables ($ps>.05$). The means were however in the hypothesised direction, in that the visually realistic drawers showed a higher mean than the intellectually realistic drawers (mean number of looks = 2.87 and 2.47 respectively).

Summary of Main Finding

1: The intellectually and visually realistic drawers showed no difference in the total amount of attention they paid towards the drawing models.

CONTINUOUS EXPOSURE

To assess the effects of the four look types (i.e. looking at the 'beginning' of the task; 'between' drawing separate elements of the model; 'within' drawing one element and looking at the 'end' of the task), only the two continuous exposure conditions were available for analysis. Therefore a 3 (age) x 2 (instruction) x 2 (task order) x 2 (drawing order) x 4 (look type) analysis of variance was performed. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was used.

Several effects were highlighted that had proved to be insignificant with the initial ANOVA (incorporating continuous and short exposures), most noticeably main effects of age ($F(2,137)=17.49$ $p<.001$) and instruction ($F(1,137)=4.46$ $p<.05$). A lack of difference with the short exposure must therefore have masked those produced by the continuous exposure. Scheffe follow-up analysis showed that the 4- and 6-year-olds, although not significantly different from each other, both looked less than the 8-year-olds (Scheffe $ps<.01$). The mean number of looks were 0.72, 0.88 and 1.31 for the 4-, 6- and 8-year olds respectively. As hypothesised, the explicit instructions led to a greater number of looks than the standard instructions (mean number of looks = 1.08 and 0.86 respectively).

Also highlighted were a significant main effect of drawing order (first/second); interactions between drawing order and age; drawing order and task order (HN/NH) and a three way interaction between all these factors ($ps<.05$). All these effects seem to derive from the 8-year-olds reducing their looking from their first to their second drawing for the HN order only.

There was a highly significant main effect of look type ($F(2,244)=242.70$ $p<.001$*) where the 'beginning' looks were greater than all other look types (Scheffe $ps<.001$), and the 'within' looks were significantly greater than the 'between' and 'end' looks (Scheffe $ps<.001$). Due to the drawing model containing only two elements i.e. the body

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

and the handle of the cup, it was not surprising that the overall levels of 'between' looks were low. See Table 3.13 for details of these means.

A significant interaction between age and look type ($F(4,244)=10.02$ $p<.001^{*}$) showed that the 4- and 6-year-olds were looking more at the 'beginning' of the task compared to all other look types (Scheffe $ps<.05$), while the 8-year-olds showed comparable levels of 'beginning' and 'within' looks (Scheffe $F(4,244)=2.37$ $p>.05^{*}$), both of which were significantly higher than the other two look types (Scheffe $ps<.001$). See Figure 3.2 for an illustration of these effects.

The significant interactions between instruction and look type ($F(2,244)=3.97$ $p<.05^{*}$) and age, instruction and look type ($F(4,244)=2.39$ $p<.05^{*}$) showed that 'within' looking was generally associated with the explicit instructions, particularly for the 8-year-olds. See Figure 3.3 for an illustration of this effect.

Significant interactions between drawing order (first/second) and look type, between drawing order, look type and task order (HN/NH), and a four way interaction incorporating all these factors and age ($ps<.01$), all seem to derive from the 8-year-olds reducing their 'within' looking from the first to second drawing with the HN order only.

<u>Summary of Main Findings</u>

1: The eight-year-olds looked at the models more than the other two age groups.

2: The explicit instructions led to increased attention.

3: Greater attention was paid to the model at the 'beginning' of the task compared to all other look types. However the eight-year-olds also showed high levels of 'within' looking, particularly with the explicit instructions.

4: More attention was paid to the first model, irrespective of which model it was.

5: The eight-year-olds showed a reduction in 'within' looking from the first to the second drawing, for the HN order alone.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 3.13 MEAN NUMBER OF LOOKS PER AGE AND LOOK TYPE

AGE	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
4	40	0.45 (2.00)	0.03 (0.13)	0.12 (0.59)	0.04 (0.16)	**0.16 (0.72)**
6	52	0.46 (2.00)	0.04 (0.14)	0.22 (1.16)	0.06 (0.23)	**0.20 (0.88)**
8	57	0.47 (2.14)	0.12 (0.46)	0.41 (2.46)	0.06 (0.20)	**0.26 (1.31)**
MEAN TOTAL		**0.46 (2.05)**	**0.07 (0.24)**	**0.27 (1.40)**	**0.06 (0.20)**	

Untransformed means (number of looks) are shown in parentheses.

FIGURE 3.2 INTERACTION OF AGE BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE (CONTINUOUS EXPOSURE)

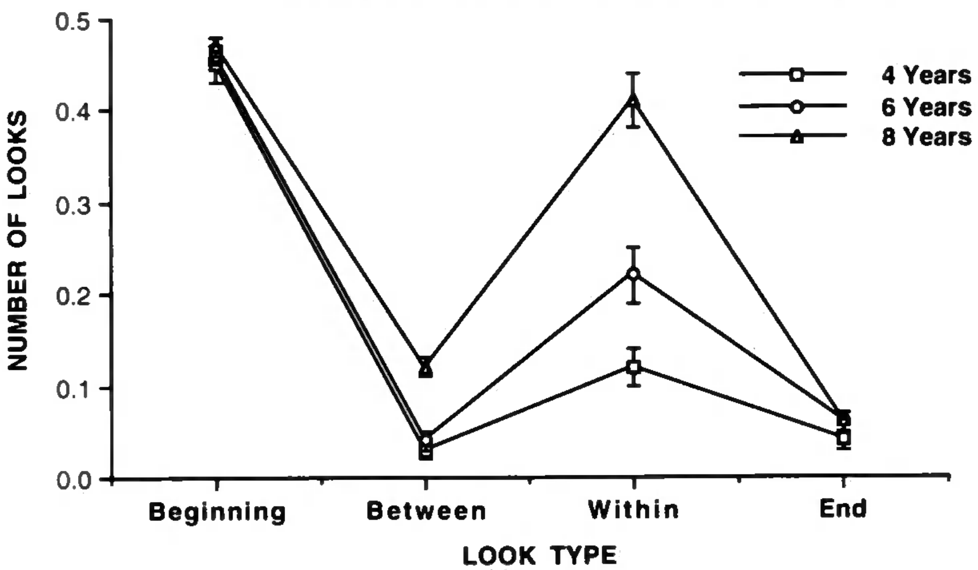
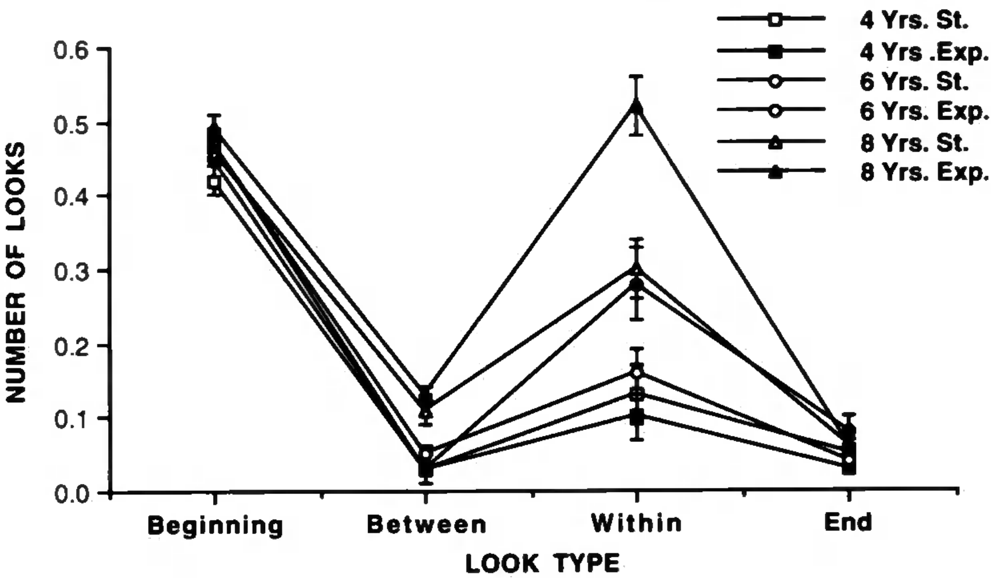


FIGURE 3.3 INTERACTION OF AGE BY INSTRUCTION BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE (CONTINUOUS EXPOSURE)



NUMBER OF LOOKS AND DRAWING REALISM

A 3 (age) x 2 (instruction) x 2 (drawing realism) x 4 (look type) analysis of variance was performed in order to compare the looking behaviour of the intellectually and visually realistic drawers with the Hidden Handle task. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed.

This showed the main effect of drawing realism approaching significance ($F(1,126)=3.49$ $p=0.064$). The means were however in the hypothesised direction with the visually realistic drawers showing a higher mean than the intellectually realistic drawers. See Table 3.14 for details of these means.

However the ANOVA did show an interaction between look type and drawing realism ($F(2,250)=3.58$ $p<.05$*). Follow-up analysis revealed that the intellectually realistic drawers looked more at the 'beginning' of the task compared to all other look types (Scheffe $ps<.001$), while the visually realistic drawers also showed significantly higher 'within' looks than both the 'between' and 'end' looks (Scheffe $ps<.01$). See Table 3.14 and Figure 3.4 for details of the means and an illustration of this effect.

Drawing realism and look type did not significantly interact with age ($F(4,250)=1.62$ $p>.05$*). This therefore suggested that the visually realistic drawers in all three of the age groups, were attending to the drawing model 'within' drawing separate elements of the model.

Summary of Main Finding

1: On the Hidden Handle task, the visually realistic drawers showed high levels of 'within' looking.

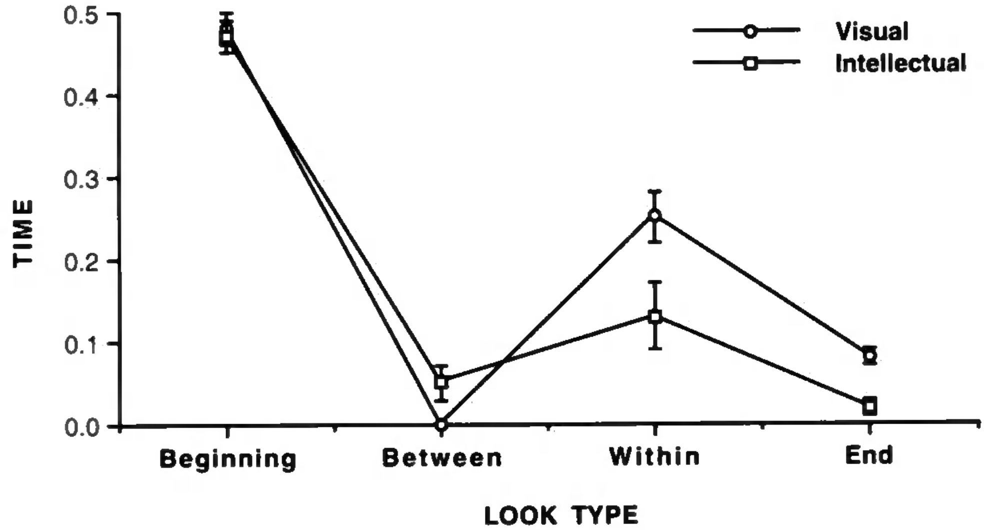
* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 3.14 **MEAN NUMBER OF LOOKS PER DRAWING REALISM AND LOOK TYPE (HIDDEN HANDLE TASK)**

REALISM	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
Visual	102	0.48 (2.28)	0.00 (0.00)	0.25 (1.38)	0.08 (0.32)	**0.20** **(1.00)**
Intellectual	36	0.47 (2.06)	0.05 (0.19)	0.13 (0.56)	0.02 (0.09)	**0.17** **(0.73)**
MEAN TOTAL		**0.47** **(2.17)**	**0.01** **(0.09)**	**0.26** **(0.97)**	**0.08** **(0.21)**	

Untransformed means (number of looks) are shown in parentheses.

FIGURE 3.4 **HIDDEN HANDLE TASK - INTERACTION OF DRAWING REALISM BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE (CONTINUOUS EXPOSURE)**



3.3.2.2 LOOKING TIME

CONTINUOUS AND SHORT EXPOSURES

In order to compare the continuous and short exposures a 3 (age) x 2 (instruction) x 2 (exposure) x 2 (task order) x 2 (drawing order) analysis of variance was performed on each child's total looking time. The four look types were therefore combined in the continuous exposure conditions. Due to unequal variances and the standard deviations being proportional to the mean squares, a reciprocal transformation was performed on the data.

The analysis showed, unlike the results for the Number of Looks measure, significant main effects of age ($F(2,274)=29.80$ $p<.001$) and instruction ($F(1,274)=22.90$ $p<.001$). Follow-up analysis revealed that the 6- and 8-year-olds were looking significantly more than the 4-year-olds (Scheffe ps<.001). As shown in Table 3.15, the 6-year-old mean was actually higher than the 8-year-olds, although not significantly, however this may suggest that the task was too simple for the older children and therefore did not require much attention. As hypothesised the explicit instructions produced greater looking than the standard instructions (mean seconds = 6.78 and 4.57 respectively).

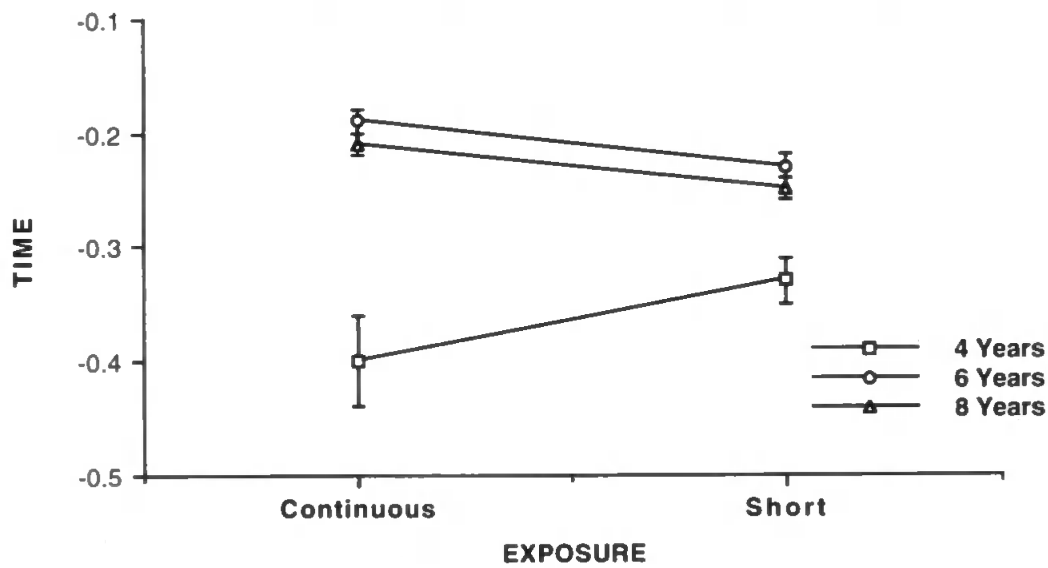
Also unlike the results for the Number of Looks measure, the analysis did not reveal a significant main effect of exposure ($F(1,274)=0.70$ $p>.05$). Therefore although the children in the short exposure conditions made fewer looks than those children in the continuous exposure conditions, they still spent a similar amount of time looking at the model. There was however a significant interaction between exposure and age ($F(2,274)=3.52$ $p<.05$). Follow-up analysis revealed that with the continuous exposure, the 6- and 8-year-olds were looking more than the 4-year-olds (Scheffe ps<.001), while the short exposure produced no age differences (Scheffe ps>.05). See Figure 3.5 and Table 3.15 for further details. The 4-year-olds' mean looking time for the short exposure was greater than the continuous exposure, although not significantly. However as detailed in Table 3.15, the untransformed means show that their looking was

TABLE 3.15 **MEAN LOOKING TIME PER AGE AND EXPOSURE**

AGE	N	CONTINUOUS	SHORT	MEAN* TOTAL
4 YEARS	80	0.40 (4.63)	0.33 (3.88)	**0.36 (4.26)**
6 YEARS	101	0.19 (8.15)	0.23 (4.91)	**0.21 (6.53)**
8 YEARS	117	0.21 (7.88)	0.25 (4.59)	**0.23 (6.24)**
MEAN TOTAL*		**0.27 (6.89)**	**0.27 (4.46)**	

* Note: Due to reciprocal transformation the short exposure shows the lowest mean. Untransformed means (seconds) are shown in parentheses.

FIGURE 3.5 **INTERACTION OF AGE BY EXPOSURE FOR LOOKING TIME MEASURE (CONTINUOUS AND SHORT EXPOSURES)**



greater for the continuous exposure. Therefore this effect seems to have been a result of the transformation.

The analysis of variance also showed a main effect of drawing order ($F(1,274)=21.36$ $p<.001$). Therefore like the results for the Number of Looks measure, more looking occurred on the first task the child was asked to draw compared to the second (mean seconds = 6.59 and 5.04 respectively).

<u>Summary of Main Findings</u>

1: The four-year-olds looked at the model less than the other two age groups. However this effect was only evident with the continuous exposure conditions.

2: The explicit instructions led to increased attention towards the model.

3: There was no overall difference in total looking time between the continuous and short exposure conditions.

4: More looking occurred on the first task the children were asked to draw irrespective of which task this was.

<u>LOOKING TIME AND DRAWING REALISM</u>

A 3 (age) x 2 (instruction) x 2 (drawing realism) x 4 (look type) analysis of variance was performed in order to compare the looking behaviour of the intellectually and visually realistic drawers with the Hidden Handle task. Due to unequal variances and the standard deviations being proportional to the mean squares, a reciprocal transformation was performed.

Unlike the results for the Number of Looks measure, this analysis showed a significant main effect of drawing realism ($F(1,262)=8.27$ $p<.01$), in that the visually realistic drawers spent more time looking at the model than the intellectually realistic drawers (mean seconds = 5.81 and 4.91 respectively). Drawing realism did not significantly interact with age ($F(2,262)=0.84$ $p>.05$), therefore suggesting that visual realism was associated with increased looking at all ages.

Summary of Main Finding

1: The visually realistic drawers on the Hidden Handle task spent more time looking at the model than the intellectually realistic drawers.

CONTINUOUS EXPOSURE

In order to assess the effects of the four look types (i.e. looking at the 'beginning' of the task; 'between' drawing separate elements of the model; 'within' drawing one element and looking at the 'end' of the task), only the two continuous exposure conditions were available for analysis. Therefore a 3 (age) x 2 (instruction) x 2 (task order) x 2 (drawing order) x 4 (look type) analysis of variance was performed. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed.

The main effects of age, instruction and drawing order ($ps<.01$) were the same as the initial ANOVA (incorporating continuous and short exposures). However two effects were highlighted that had initially proved to be insignificant. A significant interaction between age and instruction ($F(2,137)=3.18$ $p<.05$) showed that there were no age differences with the standard instructions (Scheffe $ps>.05$). However the 8-year-olds spent more time looking than the 4-year-olds with the explicit instructions (Scheffe $F(2,137)=25.39$ $p<.01$). A significant interaction between task order and drawing order ($F(1,137)=8.07$ $p<.01$) showed that there was a significant reduction in looking from the first to the second drawing with the HN order only (Scheffe $F(1,137)=40.53$ $p<.001$). This was therefore equivalent to the results for the Number of Looks measure.

The ANOVA highlighted a highly significant main effect of look type ($F(2,272)=448.63$ $p<.001$*) which, like the results for the Number of Looks measure, showed that the 'beginning' looks were greater than all other look types (Scheffe $ps<.001$), and the 'within' looks were significantly greater than the 'between' and 'end' looks (Scheffe $ps<.001$). A significant interaction between age and look type ($F(4,272)=7.52$

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

p<.001*) showed that the 6- and 8-year-olds were producing this pattern of results, while the 4-year-olds were only looking more at the 'beginning' of the task compared to all other look types (Scheffe ps<.05). See Table 3.16 and Figure 3.6 for details.

Table 3.16 also details the means for the significant interaction between look type and instruction ($F(2,272)=4.93$ $p<.01$*). Follow-up analysis revealed that the significant increase in looking with the explicit instruction was produced by the 'within' looks (Scheffe $F(2,272)=22.01$ $p<.05$*). See Figure 3.7 for an illustration of this effect.

The significant interactions between drawing order and look type, between task order, drawing order and look type, and a four way interaction between all these factors and age (ps<.01), suggested that the greatest difference between looking on the first and second task, occurred for the HN task order, for 'within' looking and for the 8-year-olds. This was therefore equivalent to the results for the Number of Looks measure.

Summary of Main Findings

1: The eight-year-olds looked at the models significantly more than the other two age groups, particularly with the explicit instructions.

2: The explicit instructions led to increased attention, in particular they increased levels of 'within' looking.

3: Greater attention was paid to the model at the 'beginning' of the task compared to all other look types. However the six- and eight-year-olds also showed high levels of 'within' looking.

4: More attention was paid to the first model, irrespective of which model it was.

5: The eight-year-olds showed a reduction in 'within' looking from the first to the second drawing for the HN order alone.

LOOKING TIME AND DRAWING REALISM

A 3 (age) x 2 (instruction) x 2 (drawing realism) x 4 (look type) analysis of variance was performed in order to compare the looking behaviour of the intellectually and

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 3.16 LOOKING TIME PER AGE, INSTRUCTION AND LOOK TYPE

AGE INSTRUCTION	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
4 YEARS	40	0.60 (3.58)	0.04 (0.19)	0.18 (0.69)	0.04 (0.17)	**0.20 (1.16)**
6 YEARS	52	0.78 (5.70)	0.06 (0.35)	0.25 (1.91)	0.05 (0.18)	**0.28 (2.04)**
8 YEARS	57	0.70 (4.43)	0.12 (0.46)	0.39 (2.73)	0.06 (0.26)	**0.31 (1.97)**
STANDARD	73	0.64 (3.87)	0.07 (0.37)	0.19 (1.06)	0.04 (0.15)	**0.24 (1.37)**
EXPLICIT	76	0.74 (5.25)	0.07 (0.30)	0.32 (2.50)	0.06 (0.25)	**0.30 (2.08)**
MEAN TOTAL		**0.70 (4.57)**	**0.08 (0.33)**	**0.27 (1.78)**	**0.05 (0.20)**	

Untransformed means (seconds) are shown in parentheses.

FIGURE 3.6 INTERACTION OF AGE BY LOOK TYPE FOR LOOKING TIME MEASURE (CONTINUOUS EXPOSURE)

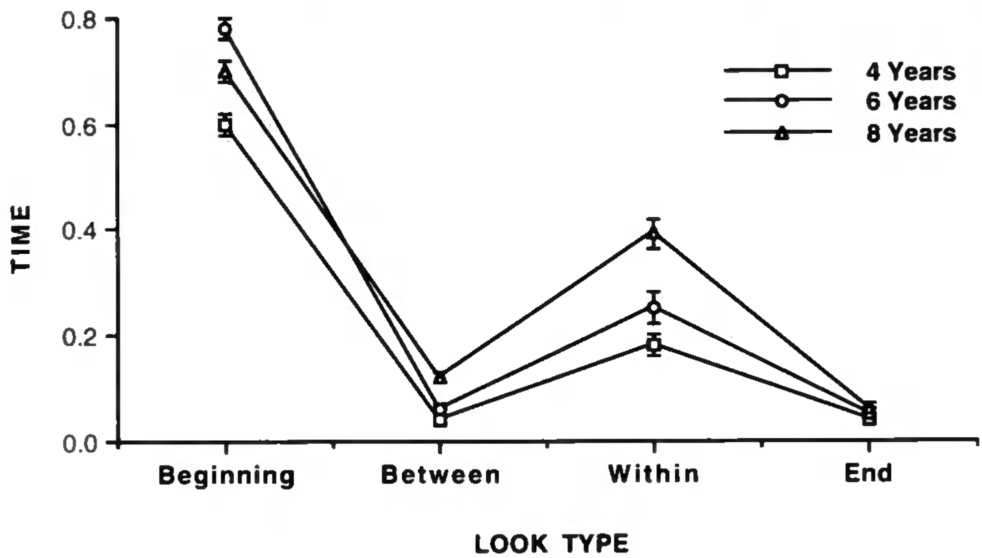
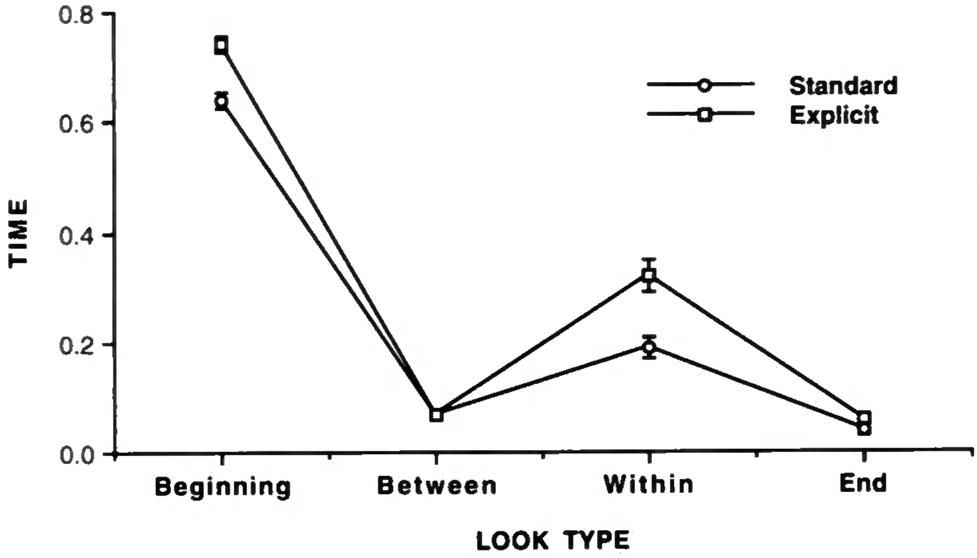


FIGURE 3.7 INTERACTION OF INSTRUCTION BY LOOK TYPE FOR LOOKING TIME MEASURE (CONTINUOUS EXPOSURE)



visually realistic drawers with the Hidden Handle task. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed.

This showed no significant main effect of drawing realism ($F(1,126)=2.26$ $p>.05$). The means were however in the hypothesised direction, i.e. the visually realistic drawers showed a higher mean than the intellectually realistic drawers. See Table 3.17 for details of these means. There was however a significant interaction between look type and drawing realism ($F(2,288)=3.73$ $p<.05$*), which revealed that the intellectually realistic drawers looked more at the 'beginning' of the task compared to all other look types (Scheffe ps<.001), while the visually realistic drawers also showed significantly higher looking 'within', than looking 'between' separate elements of the model (Scheffe ps<.001). See Table 3.17 and Figure 3.8 for details of the means and an illustration. This effect did not significantly interact with age ($F(5,288)=1.52$ $p>.05$*), therefore suggesting that the visually realistic drawers at all ages, spent more time attending to the model 'within' drawing separate elements of the model.

<u>Summary of Main Finding</u>

1: On the Hidden Handle task, the visually realism drawers showed high levels of 'within' looking.

<u>NUMBER OF LOOKS AND LOOKING TIME</u>

In order to assess the relationship between the two measures of attention, Pearson Product Moment partial correlations were performed on each child's Number of Looks and Looking Time, separately for each task. Partial correlations were used in order to control for any possible age effects. These showed positive correlations of $r=0.72$ and 0.73 (d.f.=295 ps<.001) for the Handle Visible and the Handle Hidden tasks respectively.

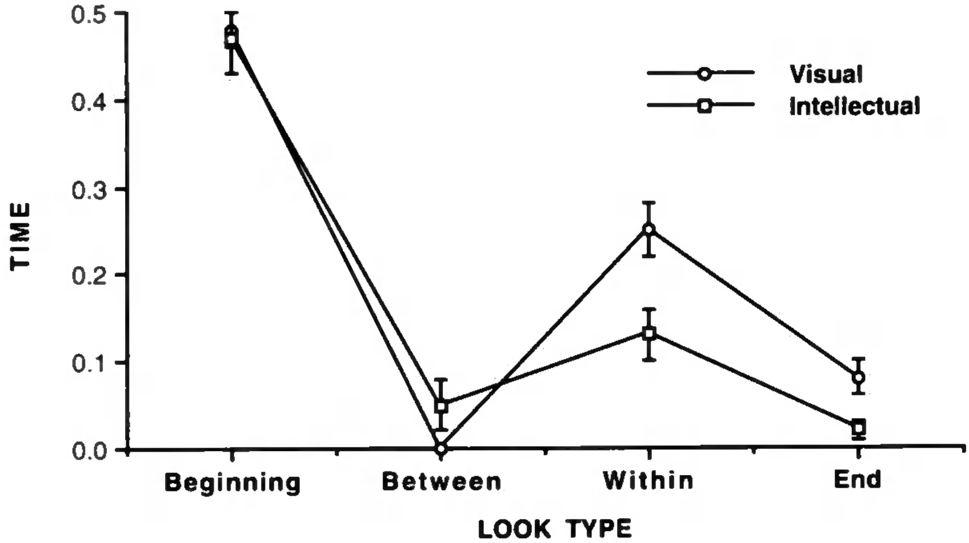
* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 3.17 **MEAN LOOKING TIME PER DRAWING REALISM AND LOOK TYPE (HIDDEN HANDLE TASK)**

REALISM	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
Visual	102	0.48 (4.80)	0.00 (0.00)	0.25 (1.89)	0.08 (0.38)	**0.20 (1.77)**
Intellectual	36	0.47 (4.46)	0.05 (0.45)	0.13 (0.45)	0.02 (0.06)	**0.17 (1.36)**
MEAN TOTAL		**0.47 (4.63)**	**0.01 (0.22)**	**0.26 (1.17)**	**0.08 (0.22)**	

Untransformed means (seconds) are shown in parentheses.

FIGURE 3.8 **HIDDEN HANDLE TASK - INTERACTION OF DRAWING REALISM BY LOOK TYPE FOR LOOKING TIME MEASURE (CONTINUOUS EXPOSURE)**



3.4 DISCUSSION

3.4.1 DRAWING DATA

The age-related changes in drawing realism for the Handle Visible task differed to those reported in Study 1. Instead of the four- and six-year-olds producing lower levels of visual realism to the eight-year-olds, the age differences came between the four- and six-year olds, therefore the six-year-olds were performing at a higher level. However the Handle Visible task presented in Study 2 was simpler than the tasks presented in Study 1. With the Handle Hidden task however the four-year-olds showed higher levels of apparent 'visual realism' with the standard instructions (which led to no age differences), and reduced levels in the EC condition. Therefore the four-year-olds performance was in opposition to the hypothesis that the Explicit Continuous condition would increase levels of visual realism.

The most consistent pattern in the four-year-old data was that they produced two identical drawings irrespective of the change in orientation of the second cup presented to them. They produced what appeared to be a 'visually realistic' drawing of the first cup and then just replicated this for their second drawing. With the HN order this pattern of results would lead to the conclusion that the child was intellectually realistic as they included the handle on the Handle Hidden task, i.e. they repeated their first correct drawing which included the visible handle. However the problem arose with classification of the drawings with the NH order. Previous literature would suggest that the four-year-old child would again produce two identical drawings of a cup with a handle. The child is producing drawings of 'a' cup, and not 'the' cup in front of them. In the present study, although 52% of the children who produced identical drawings with this order of presentation, followed this expected pattern and produced two drawings of a cup *with* a handle, the remaining 48% produced two drawings of a cup *without* a handle. Therefore although they appeared to be 'visually realistic' for the first drawing (Hidden Handle task), they were neither intellectually nor visually realistic in their second, because they omitted the visible handle. The four-year-olds could therefore, not be classified into intellectually and visually realistic categories in the same way that older children could.

This finding brings into question the results of previous studies that have only presented one cup, or did not counterbalance the order of presentation of two cups (e.g. Freeman & Janikoun, 1972).

What was particularly puzzling about the four-year-old data, was the apparent beneficial effect of the standard instructions, and in particular why the Standard Short condition led to two identical drawings without handles, while the Explicit Short condition led to two identical drawings with handles. Therefore although the four-year-olds were responding to the differing instructions they were not doing so in the same way as previous research would suggest. In fact Barrett, Beaumont & Jennett (1985) found that sensitivity to instructions only developed after the age of six years and six months. A possible explanation could be that the explicit instructions led the child to think that more was required of them, and they therefore included more items in their drawing, in this case they added the handle. Alternatively, these instructions may have aided realisation that the object was a 'cup' and therefore led the child to produce a canonical representation.

What was more difficult to account for was why the standard instructions with the short exposure apparently increased performance levels, when in theory it should have produced the lowest levels of visual realism. It could be that removal of the cup led the child to think that the experimenter was waiting for them to finish, and they therefore produced a 'quick' drawing. With the continuous exposure this was not considered because the cup was left in front of them. Therefore the child may have felt that they had more time available in order to complete their drawing. When presented with the explicit instructions in the short exposure condition, the influence of the instructions, possibly for the above stated reasons, may override this production of a quick drawing.

The four-year-olds were systematic in their drawings and therefore their data needs to be explained. However firm conclusions regarding why they produced this pattern of results are not possible from this data. Direct assessment would be necessary in order to determine what influenced the first drawing. Comparison of these results with previous research was difficult due to the procedural, instructional and drawing model variations.

Davis & Bentley (1984) provides the closest comparison however they did not detail the four-year-olds' results separately. Comparison with the results detailed in Study 1 was also difficult due to the variation in task numbers and difficulty, and the fact that the majority of children in Study 1 could have received repeated prior exposure to a Handle Visible task.

The six-year-olds had no problem with drawing the cup with its handle visible. However variations in performance between conditions were noted with the Handle Hidden task. These generally confirmed the hypotheses. When the children were presented with the standard instructions and continuous exposure to the model, prior exposure to the handle was necessary to produce visual realism with the Handle Hidden task. When presented with the explicit instructions and continuous exposure, the six-year-olds were capable of producing a visually realistic drawing of the Handle Hidden task without prior exposure. Performance deteriorated when the model was removed after the instructions were given. This age group, unlike the four-year-olds, were therefore taking notice of what was being placed in front of them, as their performance levels varied across the tasks and instructions.

The eight-year-olds had no problem with producing visually realistic drawings for either task, in any of the conditions. However slight reductions in performance, although not significant, were noted in the short exposure conditions. It seems therefore that the tasks presented in this study were too simple for this age group. In order to adequately assess the affects of short exposure to the model, it would be necessary to present more complex models to these older children. The trends in the present study seem to suggest that this would result in a reduction in performance.

3.4.2 ATTENTIONAL DATA

Study 1 detailed age related changes in attentional behaviour to be between six and eight years of age. For the present study the significant change occurred between four and six years of age. However the task was simpler and therefore it was not surprising that a lower ceiling level was reported. In fact the eight-year-olds showed a lower mean attentional score than the six-year-olds, although not significantly, further confirming the conclusion that the task was too simple for the eight-year-olds. Alternatively, it may be possible that the six-year-olds were showing high levels of attention because they are at an age where they are beginning to become aware of the need to increase their attention towards the drawing model, but are as yet unsure of the most efficient way of applying this awareness to the task. This age group therefore increase their looking at the 'beginning' of the task prior to a shift in strategy, whereby they increase their looking 'within' drawing separate elements of the model and therefore continually check their drawing with the model, as shown by the eight-year-olds.

As hypothesised, the continuous exposure conditions led to increased attention as opposed to the short exposure conditions. However although this pattern of results was produced by both the six- and eight-year-olds, the four-year-olds did not show differing patterns of attentional behaviours between the two exposure conditions. This was consistent with the findings detailed in Study 1, in that the four-year-olds generally just looked at the model at the beginning of the task, while the instructions were being given and before they began to draw. The six- and eight-year-olds continued to look at the model while they drew and therefore attention was greater with the continuous exposures. This may also provide an explanation for why the short exposures led to decreased performance levels (reduced visual realism) particularly for the six-year-olds.

The overall effect of decreased attention on the second task, irrespective of which task this was, may be particularly relevant for the four-year-olds. As discussed earlier, this age group produced two identical drawings based on what they could see of the first task, therefore ignoring the orientation of the second cup. While the older children may have reduced their looking time because they were just attending to the changed feature i.e. the handle, the four-year-olds may have shown a decrease because they tended to ignore the second model all together.

The eight-year-olds seemed to show decreased attention between the first and second task for just the HN order, and seemingly just for the 'within' looks. It is possible that this was a demonstration of the contrast effect, in that the child just attended to the changed feature (handle) on the second drawing. When the handle changed from being present to absent (HN) the child just needed to notice this. However with the reverse order (NH) the child not only had to notice the handle's presence but also draw it. The latter may therefore require more attention and so the general pattern of reduced attention for the second drawing did not occur.

More importantly, the attentional data confirmed the hypothesis that the explicit instructions would lead to increased attention. This effect was particularly associated with the continuous exposure conditions, for 'within' looking, and for the older children. The instructions therefore had the desired effect of prompting increased attention. However it was the six-year-olds who benefited most from this, because they adopted the beneficial attentional strategy of increasing their looking while they were drawing. The four-year-olds in general, employed an inappropriate strategy of increasing their looking at the beginning of the task. The eight-year-olds over employed the correct strategy even though they were capable of producing visual realistic drawings in the standard instruction, short exposure condition.

3.4.3 ATTENTION AND DRAWING REALISM

Explicit instructions with continuous exposure led to increased visual realism (for the six-year-olds) and increased attention to the model. However what was of interest was a possible relationship between these two factors. Study 1 suggested as much, however statistical limitations meant that firm conclusions could not be drawn. The present study showed that the visually realistic drawers were spending significantly more time attending to the model in front of them, than the intellectually realistic drawers. Therefore it could be concluded that the reason why the explicit instructions led to increased levels of visual realism was, at least in part, due to the fact that they increased levels of attention towards the model.

3.4.4 CONCLUSIONS

Although the attentional data confirmed the initial hypotheses the drawing data was inconclusive regarding the four- and eight-year-olds. The task seems to have been too simple for the older children and therefore presentation of a more complex task would be needed in order to adequately assess varying drawing and attentional behaviours. The four-year-olds' data was particularly puzzling and requires more detailed assessment. It seems to bring into question previous research, particularly where conclusions have been drawn using data that spans the four- to six-year-old age range (e.g. Davis & Bentley, 1984; Davis, 1983; Beal & Arnold, 1990). The present study seems to suggest that four-year-olds cannot be classified into the same drawing categories as older children, and therefore separate assessment of this age group is essential.

When presented with explicit instructions, the six-year-olds have been shown to produce visually realistic drawings of a cup with its handle hidden from view. This model consists of one object with a totally occluded feature. However it is not known whether explicit instructions would also increase performance with one object totally occluded by another structurally separate object? Similarly, it is also unknown whether any order effect would be apparent with this type of model. For example, comparing two balls one totally occluding the other, and two balls one beside the other. This first model would provide a comparison with the cup with its handle hidden at the back. The cup model presents the total occlusion of a feature that is structurally part of the whole object, while the ball model presents the total occlusion of a structurally separate object. Two balls placed side by side and touching each other, presents a non-occlusion task that would be comparable to a cup model with its handle visible at the side. Therefore a structurally separate object is visually attached to the side of another object, while the handle is structurally and visually attached to the body of the cup. By also presenting a partial occlusion ball model this would, hopefully, provide a more complex model with which to assess the eight-year-olds performance more adequately. It has been widely documented in the research literature that partial occlusion drawings incorporating the use of hidden-line elimination are particularly difficult for children to draw, especially where the two objects are identical (Cox, 1991; Freeman, 1980).

CHAPTER 4

STUDY 3
A CHANGE OF MODEL:
VISUALLY VS. STRUCTURALLY UNITED

4.1 INTRODUCTION

Chapter 1 discusses in detail the previous research that has assessed the development of total and partial occlusions in children's drawings. The main conclusions of this discussion will be reiterated in the following section in order to provide an overview of the research area.

By showing young children a cup with its handle hidden from view, Freeman & Janikoun (1972) found that they produced an intellectually realistic drawing i.e. they still drew the hidden handle. However others have shown that this tendency can be reduced by first asking the child to draw a cup with its handle visible, therefore providing a contrast (Davis & Bentley, 1984), and also by presenting explicit instructions (Barrett, Beaumont & Jennett, 1985). Study 2 manipulated both order of presentation and instructions within one experiment. This showed that six-year-olds could produce visually realistic drawings of a cup with its handle hidden, without the initial contrast, when explicit instructions were presented. However the standard instructions only led to visual realism on a handle hidden task if the child first drew a cup with its handle visible.

Through the observation and analysis of the attention each child paid towards the drawing model, it was shown that these explicit instructions increased attention, and that the visually realistic children, at all ages, were paying more attention than the intellectually realistic children. It was therefore concluded that explicit instructions led to increased levels of visual realism due, in part, to the fact that they increase attention towards the model the child is asked to draw.

As discussed in Chapter 1, it is possible that the pattern of results found by Davis (1983) and Davis & Bentley (1984) may have been affected by the fact that the cup has a defining feature, i.e. its handle. Freeman & Janikoun (1972) found that the intellectually realistic child was over concerned with drawing this defining handle, while the visually realistic child was only concerned with drawing their view of the model irrespective of defining and non defining features. Taylor & Bacharach (1982) showed that removal of the defining feature leads to reduced levels of intellectual realism. It could be possible therefore that the order and instructional effects reported in Study 2 may not be evident with a model that has no defining feature i.e. a ball. For this model the only defining feature as such, is its shape. Arrowsmith, Cox & Eames (1994) however found that five-year-olds could generalise their ability to produce a visually realistic drawing of a boy behind an orange, to a subsequent model of one orange behind another. This was therefore a partial occlusion model with no defining feature. However this task is different in that the contrast provided by Davis involved the same objects, while the Arrowsmith *et al.* study involved a contrast between different objects.

It has been suggested that children often attempt to show the distinction between structurally and visually united features of a model, in their drawings. If features are structurally united the child will draw the object's canonical representation as in the case of the cup. However if two objects are structurally separate but visually united, young children will tend to separate them out either horizontally or vertically (Cox 1981, Study 1). Even when the 'behind' relationship was pointed out to the children, 'separates' drawings were still produced by children up to seven years of age (Cox 1981, Study 2). However by not allowing the children to draw with coloured pens which matched the different coloured objects in the model, Cox & Martin (1988) found that five-year-olds did not draw the totally occluded object. This suggested that when two objects are not structurally linked the child does not show a tendency to draw the hidden object unlike drawing the hidden handle on a cup.

As discussed in Chapter 1, the introduction of communication games instead of presenting the standard drawing task provided varying results. Although Light & Simmons (1983) showed that this game situation led to increased visual realism over a control condition for seven- to eight-year-olds (but not for five- and six-year-olds), Smith & Campbell (1987) found that children continued to produce vertical separates at this age, irrespective of game or control condition. In agreement with Light & Simmons, Barrett, Beaumont & Jennett (1985) also found that five- and six-year-old children were insensitive to changes in instructions with a similar partial occlusion ball model. It seems that this type of model presents the child with a complex drawing problem (Freeman, 1980). Cox (1991) believes that when an object is completely hidden (total occlusion) most children do not see the necessity to draw it. However when part of the back object is slightly visible, as in the case of a partial occlusion model, the child has a tendency to believe both objects should be drawn, and therefore continues to produce a drawing of the two separate objects. If the two objects in the model are identical this tendency to be intellectually realistic increases (Cox, 1981). Only when the instructions become explicit (Barrett *et al.*, 1985), or the task more meaningful (Cox, 1981; Arrowsmith *et al.*, 1994) does the child seem to understand the task demands and draw in a visually realistic way.

Partial occlusion models therefore seem to be difficult to draw particularly if the two objects are identical. One of the problems detailed in Study 2 was that the cup task was too simple for the eight-year-olds. By introducing a partial occlusion model it is possible that differences in the effect of instructions might become evident at this age. In fact Barrett *et al.* reported increased visual realism with the explicit instructions in an age group ranging from six years six months to seven years and six months, for a partial occlusion ball model.

Chen & Holman (1989) directly compared performance on a cup and ball task and concluded that the ball task was more difficult. At seven years of age 94% of children produced visually realistic drawings of the cup, but it was not until nine years of age that 91% of them produced a visually realistic drawing of a partial occlusion ball model.

However, as discussed in Chapter 1, there were methodological problems in this study e.g. the contrasting models, the differences between total and partial occlusion tasks, and the instructions. These make it difficult to draw any firm conclusion regarding whether the partially occluded ball task would be more difficult than the cup task or not. However the evidence from Cox (1985) certainly suggests that two similar objects would pose more of a problem.

It was therefore decided that two identical balls would be used as models for Study 3. Firstly it was necessary to assess whether the effects of the order of presentation and instructions, demonstrated with the cup task in Study 2, were also evident with two objects visually united in the same way but structurally separate. Therefore two balls placed side by side and just touching (Non-Occlusion) would represent the comparison with the cup with its handle visible at the side. One ball placed directly behind the other (Total Occlusion) would compare with the cup with its handle turned to the back and therefore out of sight. The order of presentation of the two tasks would need to be counterbalanced and both standard and explicit instructions presented, in order to compare directly with Study 2.

In order to increase the difficulty of the task and therefore hopefully produce instructional differences for the older children, a third condition of just a Partial Occlusion model was necessary. This could be compared with the results of Barrett *et al.'s* study. Additionally a comparison could be made of all three conditions in order to assess whether there are any differences in performance across the three types of occlusion models.

With regard to the children's attention it is possible that the introduction of two objects may lead to increased attention particularly for the 'between' look type. The relationship between the body of a cup and its handle is evident in one look, or even without looking at all due to past experience. However with two separate objects the child may observe and draw the first object, then look again to assess the relationship between this and the second object. Nieland & Cox (cited in Cox, 1991) presented children with a partially occluded ball task, but interrupted the child after they had drawn the first ball, in order to draw their attention to the appearance of the scene before they drew the second ball. This however had no effect on performance. However the increased attention was forced, not spontaneous, and therefore the children may not have understood exactly what the experimenter's intentions were, and therefore did not benefit from this increased attention. Additionally, attention was drawn to the occluded ball and which parts of it could or could not be seen. Although this procedure focused attention on just 'part' of the back object, it is possible that it had much same effect as instructions that stress the 'behind' relationship, i.e. drawing attention to the back object and therefore increasing the child's belief that they are required to draw the complete contour of the second object.

Children of four, six and eight years of age were therefore divided into six conditions, with either standard or explicit instructions, and presented with either the Non-Occlusion followed by the Total Occlusion, the Total Occlusion followed by the Non-Occlusion, or just the Partial Occlusion task. The children were videoed in order to assess their attention towards the model under the varying conditions.

The hypotheses for the drawing data were that:-

1: Visual realism would increase with age.

2: Prior exposure to the Non-Occlusion model would be necessary to produce visual realism on the Total Occlusion model when presented with the standard instructions.

3: Visual realism without prior exposure to the Non-Occlusion model would occur when presented with the explicit instructions.

4: The Partial Occlusion model would result in the lowest levels of visual realism.

The hypotheses for the attentional data were that:-

1: Attention towards the model would increase with age.

2: Explicit instructions would increase attention towards the model.

3: The Partial Occlusion model would lead to increased attention.

4: Younger children would look at the model at the 'beginning' of the task while the older children would look more 'between' drawing separate elements of the model.

5: Holding the complexities of the different models constant, increased visual realism would be associated with increased attention towards the model.

4.2 METHOD

4.2.1 SUBJECTS

Two hundred and seventy children were randomly selected by the experimenter from the relevant classes in four Plymouth schools. There were ninety children in each of the three age groups. The youngest group had a mean age of 4 years 8 months (range 3:6 to 5:2, standard deviation 0:4 months), the next age group had a mean age of 6 years 4 months (range 5:6 to 7:3, standard deviation 0:5 months) and the oldest age group had a mean age of 8 years 3 month (range 7:8 to 9:5, standard deviation 0:5 months). Each age group was randomly divided into six, so that there were fifteen children in each condition. There were one hundred and thirty one males, and one hundred and thirty nine females.

4.2.2 DESIGN

A 3 (age) x 3 (condition) design was conducted, with independent groups for the first factor, and with two of the conditions having two repeated measures (task). The independent variables were condition and task, and the dependent variables were, for the drawing data, classification of drawings as visually or intellectually realistic, and for the video data, the amount of attention the child paid towards the drawing model placed in front of them.

4.2.3 MATERIALS

Two identical, featureless, pink foam balls, measuring 10 cms. in diameter were used for the drawing model. These was placed on three separate inverted boxes measuring 15 cms., 26 cms. and 32 cms. high for the four-, six- and eight-year-olds respectively, in order to ensure presentation at eye-level. Plain A5 paper and a black pencil were given to the children to draw with.

4.2.4 PROCEDURE

Each child was tested individually by the same female experimenter in a private room at their school. Once rapport had been established, the child was asked to sit squarely at a table where an inverted box had been placed directly in front of them. The height of the box varied with the age group in order to ensure that the model was placed at approximate eye level. The centre of the box was at a distance of 110 cms. from the child.

A video camera was angled to observe the child's direction of gaze and the drawing area in front of them. The experimenter tried not to draw too much attention towards the camera's presence in the room, by keeping contact with it to a minimum.

The child was given a plain piece of paper and a pencil. The experimenter then stated the instructions appropriate for the condition which the child had been assigned to. Each of the three conditions detailed below were divided into two separate instruction groups i.e. standard and explicit.

<u>Condition 1</u> To begin with the experimenter stated "I am going to ask you to do two drawings for me. Each time I want you to draw exactly what you can see from where you are sitting". The two balls were then placed side by side and just touching, on the box in front of the child (Non-Occlusion). The experimenter said "Here are two balls. Please can you draw exactly what you can see from where you are sitting". Once completed, the child was then given another plain piece of paper, and the balls were rotated so that one ball was directly behind, and just touching the other ball (Total Occlusion). The same instructions were repeated.

For the explicit instructions the procedure was exactly the same except that the experimenter first stated "I am going to ask you to do two drawings for me. Each time I want you to look very carefully so that you can draw exactly what you can see from where you are sitting". Once the model was placed the experimenter said "Here are two balls. Please look very carefully at them so that you can draw exactly what you can see from where you are sitting".

<u>Condition 2</u> The same procedure was followed except that the child first saw the Total Occlusion model followed by the Non-Occlusion model.

Condition 3 The same instructions were given except that the child was asked to produce just one drawing. This time one of the balls was placed behind and touching, but to the right of the other, so that the child viewed only part of the back ball (Partial Occlusion).

If the child was unsure of what (s)he was required to do, the instructions were repeated. The children were given as long as they required to complete each drawing. Each child was praised for their drawings and thanked for their help.

4.2.5 SCORING

DRAWING DATA

Each child's drawing(s) were classified into five categories i.e. visually realistic, intellectually realistic, miscellaneous, scribbled and, additionally for the Non-Occlusion and Partial Occlusion, omission.

1: A visually realistic drawing consisted of only those elements of the model that could be seen from the child's viewing position. For Non-Occlusion and Total Occlusion drawings, partial occlusions showing part of the back ball with a shared boundary of the front ball were also accepted. These were included due to the problem associated with the child moving from side to side or looking over the model and therefore seeing a different view to the one intended. The model was placed as far away from the child as possible in order to reduce this problem.

2: An intellectually realistic drawing either contained features that were not visible, separate discrete objects that were visually united in the model, or transparencies.

3: Omission drawings consisted of a single ball.

4: Drawings that could not be reliably classified by these criteria were classified as miscellaneous.

5: Drawings without any recognisable features were classified as scribbled.

Examples of the visually and intellectually realistic drawings obtained in each task are shown in Table 4.1.

In order to establish inter-judge reliability, 10% of the subjects were randomly selected and their drawings were re-classified by a second independent judge. Classification showed an 89% agreement. The Kappa statistic [for assessment of categorical data (Siegel & Castellan, 1988)] showed a strong agreement between judges, which was found to be significantly different from zero ($K=0.86$, $Z=8.42$ $p<.001$). The classifications of the first judge were used in the subsequent analyses.

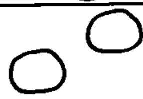
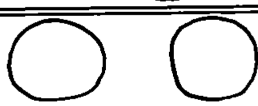
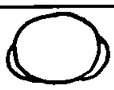
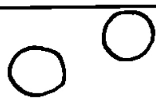
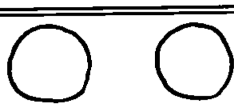
ATTENTIONAL DATA

Each child's attention towards the model in front of them was scored in two ways. Firstly the number of looks and secondly the time spent looking at the model. These two measures were divided into the Number of Looks or Looking Time at the 'beginning' of the task before drawing commenced; 'between' drawing separate elements of the model;'within' drawing a particular element and at the 'end' of the task after the drawing had been completed.

In order to establish intra-observer reliability, 10% of the subjects were randomly selected and their attention was re-assessed. Pearson Product Moment correlations were used to compare the relationship between the first and second assessments, separately for each attentional measure. There were a very high number of zero scores due to a high proportion of subjects only looking at the 'beginning' of the task. It was felt that inclusion of these scores would adversely affect the analyses. The correlation on the remaining data showed very strong relationships for the Number of Looks and Looking Time measures ($r=0.88$ and 0.96 respectively, d.f.=70, $ps<.001$).

Due to the zero scores being omitted from the correlation, intra-observer reliability of classification of attention into the four look types was assessed using the Phi Coefficient [for use with nominal data (Siegel & Castellan, 1988)]. There was a 97% agreement overall, which represented highly significant associations for the 'beginning', 'between',

TABLE 4.1 CLASSIFICATION OF DRAWINGS

DRAWING MODEL	VISUAL REALISM	INTELLECTUAL REALISM
NON-OCCLUSION		
	* 	
		
		
TOTAL OCCLUSION		
	* 	
	* 	
	* 	
		
		
		
PARTIAL OCCLUSION		
	† 	
		
		

* Classified as visually realistic due to shared boundary.

† Classified as visually realistic as consistent with Barrett, Beaumont & Jennett's (1985) classification.

'within' and 'end' look types ($r_\emptyset$ = 1.0, 0.95, 0.91 and 0.73 respectively). These scores were shown to be significantly different from zero ($X2$ = 10.25 $p<.01$, 33.03, 27.62 and 16.66 $ps<.001$, respectively).

The reliability of the attentional data was conducted on an intra-observer basis due to the scoring of the children's attention being a lengthy and complex procedure.

4.2.6 DATA ANALYSIS

DRAWING DATA

The proportions of children producing intellectually and visually realistic drawings were analysed using Log-Linear Modelling. This allows analysis of frequency data from two or more independent groups, to be assessed across two or more discrete categorical variables, therefore incorporating interaction effects. Full details of this procedure are given in Appendix C.

Where more than twenty percent of the expected cell frequencies were less than five, the Chi-Square test for independent samples was used. This allows for analysis of just one categorical variable at any one time. Where the observed set of frequencies formed a 2 x 2 contingency table, the Yates correction of continuity was applied (Siegel & Castellan, 1988). If any of these expected cell frequencies were less than five, the Fisher Exact Probability test was used. Single Sample Goodness of Fit tests were used, where data from one group was assessed across one categorical variable (Siegel, 1956).

ATTENTIONAL DATA

Analysis of Variance (ANOVA) was used to assess the amount of attention paid towards the drawing model. Where the assumption of homogeneity of variance between conditions was not met, transformations were performed on the raw data according to the criteria detailed in Howell (1987). Significant differences were assessed using Scheffe's method of multiple comparison of means (See Appendix A for full details).

4.3 RESULTS

4.3.1 DRAWING DATA

The number of children in each age group and condition, producing the different types of drawings are detailed in Table 4.2. Only those children producing either visually or intellectually realistic drawings were included in the following analyses. Where the analysis was conducted using Log-Linear Modelling, the Likelihood Ratio for Chi-Square Change for each model tested and the standardised residuals (i.e. the difference between the observed and expected frequencies based on the selected model) are detailed in Appendix F. Full details of the Log-Linear Modelling procedure are give in Appendix C.

AGE EFFECTS

A Log-Linear Model was used to assess age effects separately for the three types of occlusion drawing. For both the Total and Non-Occlusion drawings two Log-Linear Models were conducted as separating out the observed frequencies of both instructions and the order of presentation, resulted in more than the required 20% of expected cell frequencies being less than five. Therefore the observed frequencies were initially combined across instructions and then combined across order.

Backward elimination of these two Log-Linear Models for each of these drawings resulted in an interaction between age and drawing realism being sufficient to explain the observed frequencies. The Likelihood Ratios for Chi-Square Change for removal of this interaction for the Non- and Total Occlusion drawings were both highly significant (X^2=61.11 and 41.96 respectively, d.f.=2 ps<.001). Both effects of instruction and presentation order could be removed from the models without producing a significant change in the Chi-Square statistic.

For the Partial Occlusion drawing the factor of instructions could not be included as this resulted in more than the required 20% of expected cell frequencies being less than five. Therefore the observed frequencies were combined across this factor. Fisher Exact

TABLE 4.2 FREQUENCY OF DRAWINGS IN EACH CONDITION

Age	Instructions †	Visual Realism	Intellectual Realism	Ommision	Scribble	Miscellaneous	Visual Realism	Intellectual Realism	Scribble	Miscellaneous
CONDITION 1		NON-OCCLUSION (First Drawing)					TOTAL OCCLUSION (Second Drawing)			
4	Std.	1	11	2	1	0	4	10	1	0
6		2	12	0	0	1	11	4	0	0
8		11	4	0	0	0	12	2	0	1
4	Exp.	0	11	2	2	0	5	8	2	0
6		7	7	1	0	0	7	8	0	0
8		11	2	0	0	2	13	2	0	0
CONDITION 2		NON-OCCLUSION (Second Drawing)					TOTAL OCCLUSION (First Drawing)			
4	Std.	0	12	2	1	0	3	11	1	0
6		6	7	2	0	0	10	5	0	0
8		10	4	0	0	1	11	3	0	1
4	Exp.	3	11	1	0	0	1	13	1	0
6		6	9	0	0	0	7	8	0	0
8		13	2	0	0	0	11	3	0	1
CONDITION 3		PARTIAL OCCLUSION								
4	Std.	0	8	6	1	0				
6		1	13	1	0	0				
8		10	5	0	0	0				
4	Exp.	1	9	4	1	0				
6		3	9	3	0	0				
8		9	5	1	0	0				

† Std. = Standard Instructions Exp. = Explicit Instructions.

Probability tests comparing the standard and explicit instructions showed no significant age effects for either the visually or intellectually realistic drawers (Fisher Exact Test ps>.05). The Log-Linear Model resulted in an age by drawing realism interaction being sufficient to explain the observed frequencies. The Likelihood Ratio for Chi-Square Change for removal of this interaction was highly significant (X^2=25.0 d.f.=2 ps<.001).

The follow-up analysis used in the previous chapter is only applicable with dichotomous variables (Kennedy, 1983 p. 149), and as age is a polytomous variable a different follow-up analysis was necessary. Therefore, as used by Lewis, Russell & Berridge (1992), separate chi-square tests (or Fishers Exact Probability tests depending on the expected frequencies) were conducted with a correction procedure to the probability value in order to avoid type 1 errors. As the separate comparisons were nonorthogonal (not independent of each other) this was calculated using the following formula: $a' = a/c$, where a' = the error rate for any given comparison, a = the experimentwise error rate and c = the number of comparisons (Howell, 1987). Therefore for this particular follow-up analysis $a' = 0.05/3 = 0.017$.

Table 4.3 details the observed frequencies and the summary follow-up analysis for the age by drawing realism interactions, for each of the three types of drawing. For the non-occlusion and total occlusion drawings there were significant differences between each of the three age groups (X^2 ps<.017). Therefore the 4-year-olds produced proportionately less visually realistic drawings and subsequently more intellectually realistic drawings than the 6-year-olds, who in turn were less visually realistic than the 8-year-olds. The partial occlusion drawing showed that both the 4- and 6-year-olds were proportionately less visually realistic than the 8-year-olds (X^2 ps<.017).

Summary of Main Findings

1: For both the Total and Non-Occlusion tasks there was a significant increase in visual realism between each age group.

2: For the Partial Occlusion task, the eight-year-olds produced more visually realistic drawings than the younger two age groups.

TABLE 4.3 OBSERVED FREQUENCIES AND SUMMARY FOLLOW-UP ANALYSIS FOR THE AGE BY DRAWING REALISM INTERACTIONS FOR THE THREE DRAWING TYPES

	Observed Frequency			Chi-Square/Fisher Test Comparisons		
Task/ Realism †	4 Years	6 Years	8 Years	Comparison	X^2 Fisher*	P. Value
N.O.				4 and 6 Years	12.40	<0.017
V.R.	4	21	45	4 and 8 Years	53.11	<0.017
I.R.	45	35	12	6 and 8 Years	19.98	<0.017
TOTAL	49	56	57			
T.O.				4 and 6 Years	14.21	<0.017
V.R.	13	35	47	4 and 8 Years	38.94	<0.017
I.R.	42	25	10	6 and 8 Years	8.11	<0.017
TOTAL	55	60	57			
P.O.				4 and 6 Years	0.31 *	n.s.
V.R.	1	4	19	4 and 8 Years	16.34	<0.017
I.R.	17	22	10	6 and 8 Years	14.16	<0.017
TOTAL	18	26	29			

† N.O. = Non-Occlusion T.O. = Total Occlusion P.O. = Partial Occlusion.
V.R. = Visual Realism I.R. = Intellectual Realism.

* Fisher's exact probability value.

n.s. Non-significant effect at p>0.017.

FOUR-YEAR-OLDS

For the Non-Occlusion drawing no significant effects of instruction or presentation order were found (Fisher Exact Test ps>.05). There were however a greater proportion of intellectually realistic drawers overall (X^2=34.3 d.f.=1 p<.001), as detailed in Table 4.2.

For the Total Occlusion drawing two Log-Linear models were conducted. Separating out the observed frequencies of both instructions and presentation order was not possible. Therefore the observed frequencies were initially combined across instructions and then combined across order. Backward elimination of these two Log-Linear Models resulted in only the effect of drawing realism being sufficient to explain the observed frequencies in each case. The Likelihood Ratio for Chi-Square Change for removal of this effect was highly significant (X^2=16.09 d.f.=1 p<.001). Inspection of Table 4.2 reveals that there were proportionately more intellectually realistic drawings overall.

For the Partial Occlusion drawing no effect of instruction was observed (Fisher Exact Test p>.05). However a Goodness of Fit test revealed a greater proportion of intellectually realistic drawers overall (X^2=14.22 d.f.=1 p<.001).

Although the order of presentation and instructions did not affect production of visually or intellectually realistic drawings, they did affect whether or not the child produced two identical drawings (Conditions 1 and 2 only). Table 4.4 details the proportions of identical and non-identical drawings produced by the 4-year-olds in these two conditions. Although the two explicit instruction conditions did not vary in the total number of identical and non-identical drawings, the two standard instruction conditions did (X^2=6.80 d.f.=1 p<.01). Condition 1 led to more children producing two non-identical drawings, while Condition 2 led to more children producing two identical drawings, 54% of these being two horizontal separates. Only Condition 2 showed an effect of instructions in that the standard instructions led to a higher proportion of identical drawings, while the explicit instructions showed fairly even numbers of identical and non-identical drawings (Fisher Exact Test p<.05).

TABLE 4.4 FREQUENCY OF IDENTICAL AND NON-IDENTICAL DRAWINGS

CONDITION INSTRUCTION	IDENTICAL DRAWINGS			
CONDITION 1 Non-Occlusion Total Occlusion	1st:  2nd:  *	1st:  2nd: 	OTHER	TOTAL
STANDARD EXPLICIT	2 4	2 2	1 2	5 8
CONDITION 2 Total Occlusion Non-Occlusion	1st:  2nd: 	1st:  2nd:  **	OTHER	TOTAL
STANDARD EXPLICIT	2 1	9 7	2 0	13 8
	NON-IDENTICAL DRAWINGS			
CONDITION 1 Non-Occlusion Total Occlusion	1st:  2nd: 	1st:  2nd: 	OTHER	TOTAL
STANDARD EXPLICIT	2 1	6 4	2 2	10 7
CONDITION 2 Total Occlusion Non-Occlusion	1st:  2nd: 	1st:  2nd: 	OTHER	TOTAL
STANDARD EXPLICIT	1 0	0 1	1 6	2 7

* Includes one vertical separate.
** Includes two vertical separates.

Summary of Main Findings

1: The four-year-olds showed a greater proportion of intellectually realistic drawings for all three occlusion drawings.

2: The proportions of visually realistic drawings were not improved by the explicit instructions or, for the Total and Non-Occlusion drawings, the order of presentation of the tasks.

3: Standard instructions led more children to produce two non-identical drawings in Condition 1, and two identical drawings in Condition 2. The explicit instructions showed no variations in performance across the two conditions.

SIX-YEAR-OLDS

For both the Total and Non-Occlusion drawings, Log-Linear analysis resulted in no factor, i.e. instruction, presentation order or drawing realism, explaining the observed frequencies. Each factor or interaction between factors resulted in a non significant Likelihood Ratio for Chi-Square Change if it was removed from the model (ps>.05). However for the Non-Occlusion task, the effect of drawing realism did approach significance (X^2=3.54 d.f.=1 p=0.06). There was a trend towards a greater number of intellectually realistic drawers, i.e. 35 as opposed to 21 visually realistic drawers. For the Total Occlusion task the interaction between instructions and drawing realism approached significance (X^2=3.40 d.f.=1 p=0.06). The standard instructions showed a trend towards increasing visual realism (21 visually, as opposed to 9 intellectually realistic drawers), while the explicit instructions showed a trend towards increasing intellectual realism (16 intellectually, as opposed to 14 visually realistic drawers), across conditions.

The Partial Occlusion drawing showed no effect of instructions (Fisher Exact Test p>.05). However a Goodness of Fit test revealed that there were a greater proportion of intellectually realistic drawers overall (X^2=12.46 d.f.=1 p<.001).

Summary of Main Findings

1: The six-year-olds showed a greater proportion of intellectually realistic drawings for the Partial Occlusion drawing only.

2: The Total and Non-Occlusion drawings showed equal proportions of intellectually and visually realistic drawers, although the Non-Occlusion task showed a trend towards a greater proportion of intellectually realistic drawers.

3: These levels did not differ across instructions or, for the Total and Non-Occlusion drawing, the order of presentation of the tasks.

4: The Total Occlusion task showed a trend towards the standard instructions increasing visual realism, while the explicit instructions increasing intellectual realism.

EIGHT-YEAR-OLDS

For the Non-Occlusion drawing two Log-Linear models were conducted. Separating out the proportions by both instructions and presentation order was not possible. Therefore the observed frequencies were initially combined across instructions and then combined across order. Backward elimination of these two Log-Linear Models resulted in only the effect of drawing realism being sufficient to explain the observed frequencies in each case. The Likelihood Ratio for Chi-Square Change for removal of this effect was highly significant (X^2=20.35 d.f.=1 p<.001). Inspection of the data in Table 4.2 reveals that there were proportionately more visually realistic drawings.

For the Total Occlusion drawing no effects of instruction or presentation order were observed (Fisher Exact Test ps>.05). However the Goodness of Fit test revealed that overall there were a greater proportion of visually realistic drawers (X^2=12.46 d.f.=1 p<.001). For the Partial Occlusion drawing no effects of instruction (Fisher Exact Test p>.05) or drawing realism were observed (X^2=2.97 d.f.=1 p>.05).

Summary of Main Findings

1: The eight-year-olds showed a greater proportion of visually realistic drawings for the Total and Non-Occlusion drawings.

2: Equal proportions of intellectually and visually realistic drawings were observed for the Partial Occlusion task.

3: The proportions of visually realistic drawings were not improved by the explicit instructions or, for the Total and Non-Occlusion drawing, the order of presentation of the tasks.

COMPARISON ACROSS CONDITIONS

The performance of each age group was assessed across all three conditions, with only the first drawing of Conditions 1 and 2 being taken into account. This therefore allowed assessment of how the proportions of visual and intellectual realism varied between a Non-, a Total and a Partial Occlusion drawing, unaffected by order of presentation.

For the 4-year-olds, analysis showed that there were no significant differences between the conditions or instructions (Fisher Exact Test ps>.05). Inspection of the data in Table 4.2 shows that the 4-year-olds were consistently intellectually realistic, with this overall difference being highly significant (X^2=47.08 d.f.=1 p<.001).

Backward elimination of a Log-Linear Model for the 6-year-olds resulted in the condition by instruction by drawing realism interaction explaining the observed frequencies. The Likelihood Ratio for Chi-Square Change for removal of this interaction was significant (X^2=6.02 d.f.=2 p<.05). Table 4.5 details the observed frequencies and the summary of the follow-up analysis for this interaction. For this follow-up the probability value was p=0.008 due to six comparisons being made (0.05/6 = 0.008). However non of the comparisons across the three conditions were significant, although there were a greater number of intellectually realistic drawers overall (X^2=6.86 d.f.=1 p<.01). Inspection of the observed frequencies in Table 4.5 shows that the Total Occlusion task seems to have led to high levels of visual realism with the standard instructions, which is in opposition to the hypothesis and the observed frequencies of the other two tasks.

For the 8-year-olds two Log-Linear models were conducted. Separating out the proportions by both conditions and instructions was not possible, therefore the observed frequencies were initially combined across instructions and then combined across conditions. Both these analyses resulted in drawing realism only explaining the

TABLE 4.5 OBSERVED FREQUENCIES AND SUMMARY FOLLOW-UP ANALYSIS FOR THE CONDITION BY INSTRUCTION BY DRAWING REALISM INTERACTION (SIX-YEAR-OLDS)

	Observed Frequency †			Chi-Square/Fisher Test Comparisons		
Realism/ Instruction †	N.O. (Condition 1)	T.O. (Condition 2)	P.O. (Condition 3)	Comparison	X^2 Fisher*	P. Value
V.R.				N.O. and T.O.	0.08 *	n.s.
Standard	2	10	1	N.O. and P.O.	0.69 *	n.s.
Explicit	7	7	3	T.O. and P.O	0.26 *	n.s.
I.R.				N.O. and T.O.	1.89	n.s.
Standard	12	5	13	N.O. and P.O.	0.07	n.s.
Explicit	7	8	9	T.O. and P.O	1.39	n.s.
TOTAL	28	30	26			

† N.O. = Non-Occlusion T.O. = Total Occlusion P.O. = Partial Occlusion.
V.R. = Visual Realism I.R. = Intellectual Realism.

* Fisher's exact probability value.

n.s. Non-significant effect at p>0.008.

observed frequencies. As can be seen from Table 4.2, the 8-year-olds were consistently visually realistic across conditions. The Likelihood Ratio for Chi-Square Change for removal of this factor was highly significant (X^2=20.63 d.f.=1 p<.001).

Summary of Main Findings

1: The four- and six-year-olds were consistently intellectually realistic across tasks.

2: The eight-year-olds were consistently visually realistic across tasks.

4.3.2 ATTENTIONAL DATA

The following sections detail the main findings of the attentional data. Full analysis of variance summary tables and details of the subsidiary results are given in Appendix G.

4.3.2.1 NUMBER OF LOOKS

CONDITIONS 1 AND 2

A 3 (age) x 2 (condition) x 2 (instruction) x 2 (drawing order) x 4 (look type) analysis of variance was performed on the number of times each child looked at the model in front of them, under Conditions 1 and 2. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data. The analysis revealed a highly significant main effect of age (F(2,168)=31.29 p<.001). Follow-up analysis showed that the 4-year-olds looked at the model significantly less than the 6- and 8-year-olds (Scheffe ps<.001) (mean number of looks = 0.55, 1.01 and 0.96 respectively).

The ANOVA also showed highly significant main effects of instruction (F(1,168)=22.90 p<.001) and drawing order (F(1,168)=48.44 p<.001), and an interaction between the two (F(1,168)=7.75 p<.01). As detailed in Table 4.6 the explicit instructions led to increased attention towards the model, and the children paid less attention on their second drawing. Follow-up analysis of the interaction showed that although the main effect of drawing order was evident with both instructions the effect showed a higher level of

TABLE 4.6 MEAN NUMBER OF LOOKS PER INSTRUCTIONS AND DRAWING ORDER

ORDER INSTRUCTION	FIRST DRAWING	SECOND DRAWING	MEAN TOTAL
STANDARD	0.18 (0.78)	0.15 (0.60)	**0.16** **(0.69)**
EXPLICIT	0.24 (1.20)	0.18 (0.79)	**0.21** **(0.99)**
MEAN TOTAL	**0.21** **(0.99)**	**0.17** **(0.70)**	

Untransformed means (number of looks) are shown in parentheses.

significance with the explicit instructions (Scheffe $F(1,168)=47.72$ $p<.001$). Similarly, the main effect of instructions showed a higher level of significance with the first drawing (Scheffe $F(1,168)=47.72$ $p<.001$). See Figure 4.1 for an illustration of these effects.

The ANOVA showed a highly significant main effect of look type ($F(3,444)=504.11$ $p<.001$*), as detailed in Table 4.7. Follow-up analysis revealed that more looks occurred at the 'beginning' of the task compared to all other look types (Scheffe ps<.001), and fewer looks occurred at the 'end' compared to all other look types (Scheffe ps<.05). A highly significant interaction between age and look type ($F(5,444)=8.70$ $p<.001$*) showed that although all ages were looking more at the 'beginning' of the task compared to all other look types (Scheffe ps<.001), the 8-year-olds were also looking more 'between' than at the 'end' of the task (Scheffe $F(5,444)=40.68$ $p<.01$*). Although the 'beginning' and 'end' look types showed no differences across age (Scheffe ps>.05), the 8-year-olds were looking more both 'between' and 'within' than the 4-year-olds (Scheffe ps<.001). Therefore the 8-year-olds were continuing to check their drawing with their view of model in front of them. The means are detailed in Table 4.7 and Figure 4.2 illustrates this interaction.

The ANOVA also showed significant interactions between instruction and look type ($F(3,444)=3.37$ $p<.05$*) and between drawing order and look type ($F(3,492)=8.02$ $p<.001$*). The means are detailed in Table 4.8. Follow-up analysis concluded that although both instructions led to more looking at the 'beginning' of the task (Scheffe ps<.001), it was only the explicit instructions that produced more looking 'between' than at the 'end' of the task (Scheffe $F(3,444)=37.67$ $p<.01$*). Follow-up analysis also showed that the main effect of drawing order was only evident with the 'beginning' looks (Scheffe $F(3,492)=57.03$ $p<.001$*).

__Summary of Main Findings__

1: The four-year-olds looked at the model less frequently than both the six- and eight-year-olds.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 4.7 MEAN NUMBER OF LOOKS PER AGE AND LOOK TYPE

AGE	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
4	60	0.45 (1.96)	0.03 (0.12)	0.01 (0.03)	0.01 (0.11)	**0.13 (0.55)**
6	60	0.55 (2.76)	0.13 (0.51)	0.09 (0.53)	0.07 (0.23)	**0.21 (1.01)**
8	60	0.47 (2.09)	0.20 (0.72)	0.16 (0.83)	0.06 (0.22)	**0.22 (0.96)**
MEAN TOTAL		**0.49 (2.27)**	**0.12 (0.45)**	**0.09 (0.46)**	**0.05 (0.19)**	

Untransformed means (number of looks) are shown in parentheses.

TABLE 4.8 MEAN NUMBER OF LOOKS PER INSTRUCTION, DRAWING ORDER AND LOOK TYPE

INSTRUCTION	N	BEGINNING	BETWEEN	WITHIN	END
STANDARD	90	0.46 (2.03)	0.09 (0.29)	0.06 (0.26)	0.05 (0.18)
EXPLICIT	90	0.52 (2.51)	0.16 (0.61)	0.12 (0.67)	0.05 (0.19)
DRAWING ORDER					
FIRST	180	0.54 (2.63)	0.13 (0.49)	0.11 (0.61)	0.06 (0.21)
SECOND	180	0.44 (1.91)	0.11 (0.40)	0.07 (0.32)	0.05 (0.16)

Untransformed means (number of looks) are shown in parentheses.

FIGURE 4.1 INTERACTION OF INSTRUCTION BY DRAWING ORDER FOR NUMBER OF LOOKS MEASURE (CONDITIONS 1 AND 2)

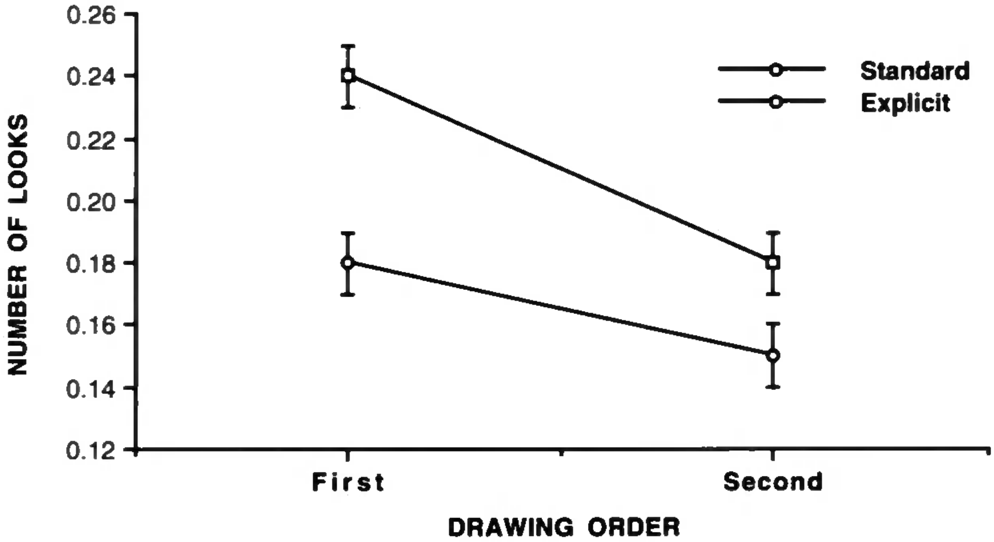
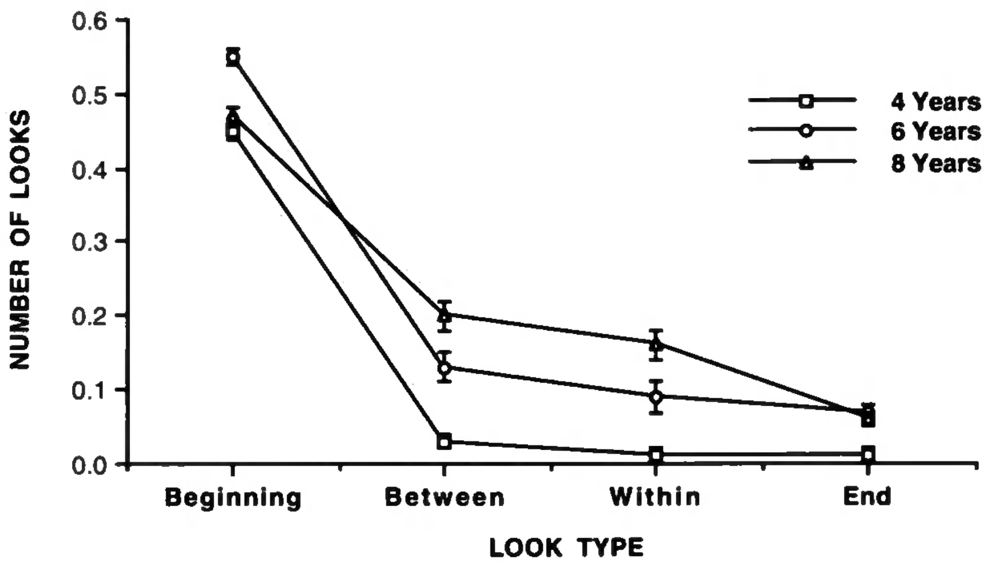


FIGURE 4.2 INTERACTION OF AGE BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE (CONDITIONS 1 AND 2)



2: More attention was paid to the model at the 'beginning' of the task, while the lowest levels of looking occurred at the 'end' of the task. The eight-year-olds however showed high levels of 'within' and 'between' looking.

3: The explicit instructions led to higher levels of attention than the standard instructions, particularly 'within' drawing separate elements of the model.

4: More attention was paid to the first task, irrespective of which task this was. This effect was only evident with the 'beginning' looks.

NUMBER OF LOOKS AND DRAWING REALISM

Two 3 (age) x 2 (condition) x 2 (realism) x 4 (look type) ANOVAs were performed in order to compare the looking behaviour of the intellectually and visually realistic drawers with regard to their Number of Looks for Conditions 1 and 2. It was not possible to analyse both the Total and the Non-Occlusion drawings together because a child did not necessarily fall into the same category of realism for both tasks. It was not possible to include the factor of instructions in this analysis due to a lack of intellectually realistic four-year-olds in the explicit instruction condition. Due to unequal variances and the standard deviations being proportional to the means, log(10) transformations were performed.

For the Non-Occlusion model the main effect of drawing realism approached significance ($F(1,150)=3.74$ $p=0.055$). However inspection of the means in Table 4.9 reveals that this factor interacted with look type ($F(3,412)=3.54$ $p<.05$*). Follow-up analysis showed that the visually realistic drawers were looking more 'between' than the intellectually realistic drawers (Scheffe $F(3,142)=30.86$ $p<.01$*). See Figure 4.3 for an illustration of this effect.

For the Total Occlusion model there was no significant main effect of drawing realism ($F(1,163)=0.70$ $p>.05$). The mean number of looks were however in the hypothesised direction i.e. 0.83 and 0.86 for the intellectually and visually realistic drawers respectively.

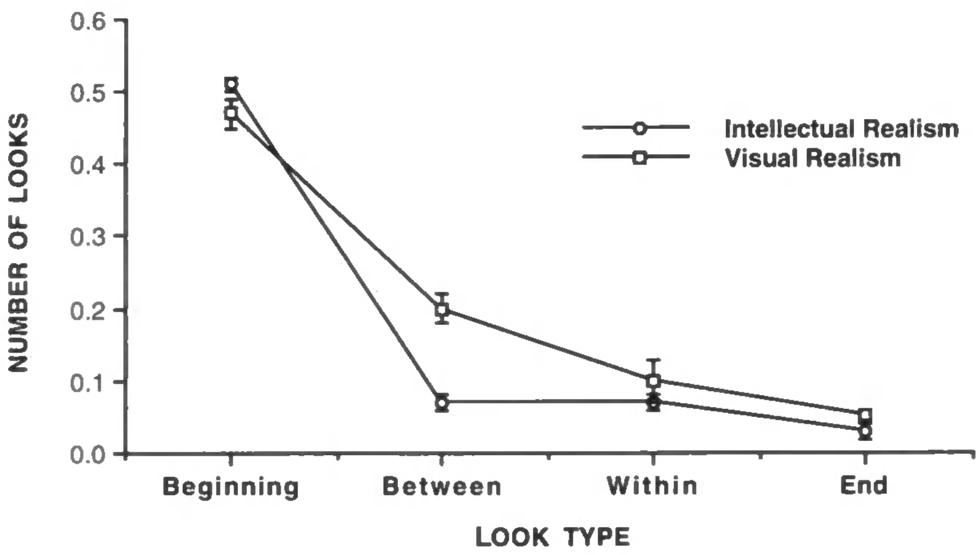
* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 4.9 MEAN NUMBER OF LOOKS PER DRAWING REALISM AND LOOK TYPE (NON-OCCLUSION TASK)

REALISM	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
INTEL-LECTUAL	93	0.51 (2.44)	0.07 (0.25)	0.07 (0.15)	0.03 (0.12)	**0.17 (0.74)**
VISUAL	69	0.47 (2.36)	0.20 (0.75)	0.10 (0.84)	0.05 (0.20)	**0.21 (1.04)**
MEAN TOTAL		**0.49 (2.41)**	**0.14 (0.46)**	**0.09 (0.44)**	**0.04 (0.15)**	

The untransformed means (number of looks) are shown in parentheses.

FIGURE 4.3 NON-OCCLUSION TASK - INTERACTION OF DRAWING REALISM BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE



Summary of Main Findings

1: For the Non-Occlusion task, the visually realistic drawers paid more attention to the model 'between' drawing separate elements of the model, than the intellectually realistic drawers.

2: The Total Occlusion task showed no such differences in attention.

CONDITIONS 1, 2 AND 3 (FIRST DRAWING ONLY)

A 3 (age) x 3 (condition) x 2 (instruction) x 4 (look type) analysis of variance was performed in order to compare performance across the three drawing tasks. Therefore for Conditions 1 and 2 only the child's first drawing was taken into account, i.e. the Non-Occlusion and the Total Occlusion respectively. Their drawings were therefore unaffected by presentation order, although this had proved to be an non-significant factor in the initial analysis detailed above. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

The ANOVA showed a main effect of age ($F(2,252)=29.52$ $p<.001$) in that the 4-year-olds looked at the model less frequently than the 6- and 8-year-olds (Scheffe $F(2,252)=30.95$ and 55.97 respectively, $ps<.001$) (mean number of looks = 0.69, 1.14 and 1.14 respectively). There was also a main effect of instructions ($F(1,252)=20.25$ $p<.001$) in that the explicit instructions led to increased attention. These results were therefore in agreement with the ANOVA for Conditions 1 and 2. There was however no significant main effect of condition ($F(2,252)=0.33$ $p>.05$), therefore looking behaviour did not vary across the three types of occlusion drawing.

The ANOVA showed a highly significant main effect of look type ($F(3,677)=501.02$ $p<.001$*), as detailed in Table 4.10. Follow-up analysis revealed that more looks occurred at the 'beginning' compared to all other look types (Scheffe $ps<.001$), and fewer looks occurred at the 'end' of the task compared to all other look types (Scheffe $ps<.01$). This therefore agreed with the initial analysis of Conditions 1 and 2.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 4.10 MEAN NUMBER OF LOOKS PER AGE AND LOOK TYPE

AGE	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
4	90	0.51 (2.42)	0.04 (0.13)	0.01 (0.07)	0.05 (0.16)	**0.15 (0.69)**
6	90	0.60 (3.22)	0.12 (0.56)	0.09 (0.56)	0.07 (0.24)	**0.23 (1.14)**
8	90	0.50 (2.37)	0.21 (0.74)	0.22 (1.22)	0.07 (0.23)	**0.25 (1.14)**
MEAN TOTAL		**0.54 (2.67)**	**0.13 (0.48)**	**0.11 (0.61)**	**0.06 (0.21)**	

Untransformed means (number of looks) are shown in parentheses.

Table 4.10 also details the highly significant interaction between age and look type ($F(5,677)=11.93$ $p<.001^{*}$). Follow-up analysis showed that all ages were looking more at the 'beginning' of the task compared to all other look types (Scheffe ps<.001), but the 8-year-olds were also looking less at the 'end' of the task compared to all other look types (Scheffe $ps<.01^{*}$). The 8-year-olds were therefore accounting for the main effect. Although the 'beginning' and 'end' look types showed no differences across age (Scheffe ps>.05), the 6- and 8-year-olds were both looking more 'between', and the 8-year-olds were looking more 'within', than the 4-year-olds (Scheffe ps<.05). Therefore the 6- and 8-year-olds were continuing to check their drawing with their view of the model in front of them. See Figure 4.4 for an illustration of this interaction and the main effects of age and look type.

The ANOVA also showed a significant interaction between instruction and look type ($F(3,677)=3.32$ $p<.05^{*}$). Follow-up analysis on the means detailed in Table 4.11, revealed that, although both instructions led to more looking at the 'beginning' of the task (Scheffe ps<.001), it was only the explicit instructions that produced more looking 'between' than at the 'end' of the task (Scheffe $F(3,677)=31.23$ $p<.01^{*}$). This was therefore in agreement with the analysis of Conditions 1 and 2.

Summary of Main Findings

1: The four-year-olds looked at the model less frequently than both the six- and eight-year-olds.

2: There was no difference in the frequency of looks towards the Non-Occlusion, Total Occlusion and Partial Occlusion models.

3: The explicit instructions led to higher levels of attention than the standard instructions, particularly 'between' drawing separate elements of the model.

4: More attention was paid to the model at the 'beginning' of the task, while the lowest levels of looking occurred at the 'end' of the task. The eight-year-olds however showed high levels of 'within' and 'between' looking, and the six-year-olds showed high levels of 'between' looking.

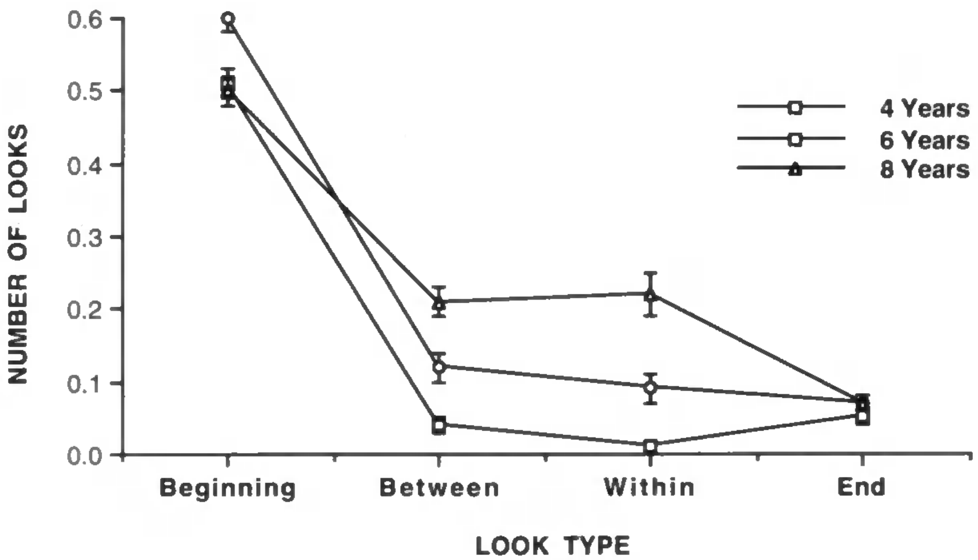
* Epsilon corrected (Greenhouse Geiser) degrees of freedom and probability values.

TABLE 4.11 MEAN NUMBER OF LOOKS PER INSTRUCTION AND LOOK TYPE

INSTRUCTION	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
STANDARD	135	0.51 (2.47)	0.09 (0.30)	0.08 (0.40)	0.06 (0.21)	**0.19 (0.84)**
EXPLICIT	135	0.56 (2.87)	0.17 (0.66)	0.14 (0.83)	0.06 (0.21)	**0.23 (1.14)**
MEAN TOTAL		**0.54 (2.67)**	**0.13 (0.48)**	**0.11 (0.61)**	**0.06 (0.21)**	

Untransformed means (number of looks) are shown in parentheses.

FIGURE 4.4 INTERACTION OF AGE BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE (CONDITIONS 1, 2 AND 3)



NUMBER OF LOOKS AND DRAWING REALISM

In order to compare the looking behaviour of the intellectually and the visually realistic drawers across the three conditions, a further 3 (age) x 3 (condition) x 2 (realism) x 4 (look type) ANOVA was performed with a log(10) transformation. It was again not possible to include the factor of instructions in this analysis.

The main effect of drawing realism was not significant ($F(1,222)=1.23$ $p>.05$). However the mean number of looks were in the hypothesised direction i.e. 1.17 for the visually realistic, and 0.93 for intellectually realistic drawers. There was also no significant interaction between drawing realism and look type ($F(3,666)=0.94$ $p>.05$).

Summary of Main Finding

1: There was no difference in the attention paid towards the model between the intellectually and visually realistic drawers.

4.3.2.2 LOOKING TIME

CONDITIONS 1 AND 2

A 3 (age) x 2 (condition) x 2 (instruction) x 2 (drawing order) x 4 (look type) analysis of variance was performed on the time each child spent looking at the model in front of them, under Conditions 1 and 2. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

The ANOVA showed a highly significant main effect of age ($F(2,168)=47.10$ $p<.001$) where the 4-year-olds looked at the model significantly less than the 6- and 8-year-olds (Scheffe $F(2,168)=58.64$ and 80.37 respectively $ps<.001$) (mean seconds = 1.09, 2.05 and 1.85 respectively). The ANOVA also showed highly significant main effects of instruction ($F(1,168)=26.55$ $p<.001$) and drawing order ($F(1,168)=35.74$ $p<.001$). As detailed in Table 4.12 the explicit instructions led to increased attention towards the model, and the children paid less attention to the model on their second drawing.

TABLE 4.12 MEAN LOOKING TIME PER INSTRUCTIONS AND DRAWING ORDER

ORDER INSTRUCTION	FIRST DRAWING	SECOND DRAWING	MEAN TOTAL
STANDARD	0.24 (1.50)	0.22 (1.22)	**0.23 (1.36)**
EXPLICIT	0.31 (2.32)	0.25 (1.61)	**0.28 (1.96)**
MEAN TOTAL	**0.28 (1.96)**	**0.24 (1.36)**	

Untransformed means (seconds) are shown in parentheses.

The ANOVA also revealed an interaction between instruction and drawing order (F(1,168)= 9.98 p<.01). Follow-up analysis showed that the main effect of drawing order was in fact only evident with the explicit instructions (Scheffe F(1,168)=40.58 p<.001), and the main effect of instructions was only evident on the first drawing (Scheffe F(1,168)= 55.23 p<.001). See Table 4.12 for details of these means.

Unlike the results for the Number of Looks measure, Looking Time also showed an interaction between condition by drawing order (F(1,168)=5.93 p<.05), although overall there was no main effect of condition (F(1,168)=0.44 p>.05). Follow-up analysis of the means detailed in Table 4.13 revealed that the main effect of drawing order was only evident with Condition 2 (Scheffe F(1,168)=40.58 p<.001). Therefore if the child was presented with the Total Occlusion model followed by the Non-Occlusion model (Condition 2) their looking time reduced from the first to the second drawing. However if the reverse order was presented (Condition 1) this did not occur. Therefore presentation of the Total Occlusion model first (Condition 2) increased attention. This effect is illustrated in Figure 4.5.

The ANOVA showed a very highly significant main effect of look type (F(3,449)=1429.81 p<.001*), the means for which are detailed in Table 4.14. Follow-up analysis revealed that more looks occurred at the 'beginning' compared to all other look types (Scheffe ps<.001), the 'between' looks were greater than the 'within' and 'end' looks (Scheffe ps<.01), and fewer looks occurred at the 'end' of the task compared to all other look types (Scheffe ps<.05).

A highly significant interaction between age and look type (F(5,449)=9.42 p<.001*) showed that all ages were looking more at the 'beginning' of the task compared to all other look types (Scheffe ps<.001), but the 8-year-olds were also looking more 'between' than at the 'end' of the task (Scheffe F(5,449)=56.41 p<.001*). Although the 'end' look type showed no differences across age (Scheffe ps>.05), the 8-year-olds were looking more both 'between' and 'within' than the 4-year-olds (Scheffe ps<.01), and the 6-year-olds

* Epsilon corrected (Greenhouse Geiser) degrees of freedom and probability values.

TABLE 4.13 **MEAN LOOKING TIME PER CONDITION AND DRAWING ORDER**

ORDER CONDITION †	FIRST DRAWING	SECOND DRAWING	MEAN TOTAL
CONDITION 1 (N.O. / T.O.)	0.26 (1.88)	0.24 (1.46)	**0.25 (1.67)**
CONDITION 2 (T.O. / N.O.)	0.29 (1.94)	0.23 (1.37)	**0.26 (1.66)**
MEAN TOTAL	**0.28 (1.96)**	**0.24 (1.36)**	

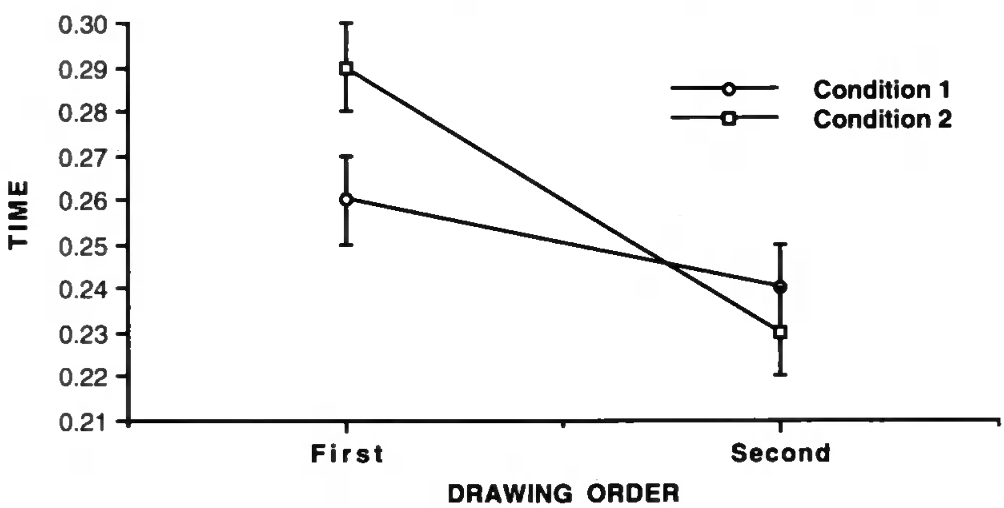
† N.O. / T.O. = Non-Occlusion task followed by Total Occlusion task.
T.O. / N.O. = Total Occlusion task followed by Non-Occlusion task.
Untransformed means (seconds) are shown in parentheses.

TABLE 4.14 **MEAN LOOKING TIME PER AGE AND LOOK TYPE**

AGE	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
4	60	0.68 (4.21)	0.03 (0.09)	0.01 (0.02)	0.02 (0.05)	**0.18 (1.09)**
6	60	0.87 (6.85)	0.13 (0.58)	0.09 (0.55)	0.05 (0.21)	**0.28 (2.05)**
8	60	0.79 (5.65)	0.22 (0.87)	0.15 (0.69)	0.05 (0.17)	**0.30 (1.85)**
MEAN TOTAL		**0.78 (5.57)**	**0.13 (0.51)**	**0.08 (0.42)**	**0.04 (0.15)**	

Untransformed means (seconds) are shown in parentheses.

FIGURE 4.5 **INTERACTION OF CONDITION BY DRAWING ORDER FOR LOOKING TIME MEASURE (CONDITIONS 1 AND 2)**



were looking more at the 'beginning' than the 4-year-olds (Scheffe $F(5,449)=70.46$ $p<.001$). See Table 4.14 for details of these means. Therefore the 8-year-olds were continuing to check their drawing with their view of the model in front of them, and the 6-year-olds are showing a high level of looking at the 'beginning' of the task. Figure 4.6 illustrates this interaction and the main effects.

Table 4.15 details the mean scores for the significant interactions between instruction and look type ($F(3,449)=5.28$ $p<.01^*$), and between drawing order and look type ($F(3,483)=8.43$ $p<.001^*$). Follow-up analysis concluded that although both instructions led to more looking at the 'beginning' of the task (Scheffe ps<.001), it was only the explicit instructions that produced more looking 'between' than at the 'end' of the task (Scheffe $F(3,449)=42.16$ $p<.001^*$).

Follow-up analysis also showed that the main effect of drawing order was only evident with the 'beginning' looks (Scheffe $F(3,483)=55.53$ $p<.001^*$). Both drawing orders showed the 'beginning' looks greater than all other look types (Scheffe ps<.001), but while the first drawing resulted in both the 'between' and 'within' looks being greater than the 'end' looks (Scheffe ps<.05), the second drawing only showed the 'between' looks greater than the 'end' looks (Scheffe $F(3,483)=27.54$ $p<.01^*$).

Summary of Main Findings

1: The four-year-olds paid less attention than both the six- and eight-year-olds.

2: High levels of attention were paid to the model at the 'beginning' of the task and 'between' drawing separate elements of the model. However it was the eight-year-olds who produced the high level of 'between' looking. The six-year-olds showed high levels of looking at the 'beginning' of the task.

3: The explicit instructions led to higher levels of attention than the standard instructions, particularly 'between' drawing separate elements of the model.

4: More attention was paid to the first task, particularly for Condition 2 and for the 'beginning' looks.

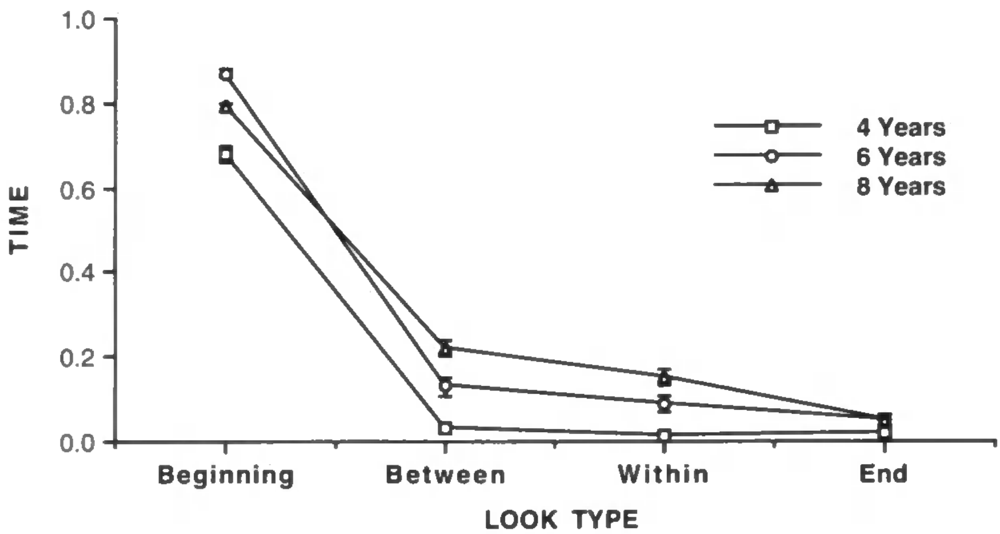
*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 4.15 MEAN LOOKING TIME PER LOOK TYPE, INSTRUCTION AND DRAWING ORDER

INSTRUCTION	N	BEGINNING	BETWEEN	WITHIN	END
STANDARD	90	0.73 (4.68)	0.09 (0.35)	0.06 (0.31)	0.04 (0.12)
EXPLICIT	90	0.83 (6.46)	0.16 (0.68)	0.10 (0.54)	0.04 (0.17)
DRAWING ORDER					
FIRST	180	0.82 (6.36)	0.14 (0.60)	0.10 (0.55)	0.04 (0.13)
SECOND	180	0.73 (4.78)	0.11 (0.43)	0.06 (0.29)	0.04 (0.16)

Untransformed means (seconds) are shown in parentheses.

FIGURE 4.6 INTERACTION OF AGE BY LOOK TYPE FOR LOOKING TIME MEASURE (CONDITIONS 1 AND 2)



LOOKING TIME AND DRAWING REALISM

Two 3 (age) x 2 (condition) x 2 (realism) x 4 (look type) ANOVAs were performed in order to compare the looking behaviour of the intellectually and visually realistic drawers separately for the Total and the Non-Occlusion drawings. Due to unequal variances and the standard deviations being proportional to the means, log(10) transformations were performed on the data.

For the Non-Occlusion model there was a main effect of drawing realism ($F(1,150)=6.51$ $p<.05$), in that the visually realistic drawers looked more than the intellectually realistic drawers. There was no interaction between drawing realism and age ($F(2,150)=0.81$ $p>.05$) suggesting that increased looking for visually realistic drawers was evident across each age group. See Table 4.16 for details of these means. For the Total Occlusion model no effect of drawing realism was found ($F(1,163)=2.09$ $p>.05$). However the means were in the hypothesised direction i.e. 1.45 and 1.96 seconds, for the intellectually and visually realistic drawers respectively.

Summary of Main Findings

1: For the Non-Occlusion task, the visually realistic drawers spent more time looking at the model than the intellectually realistic drawers, at all ages.

2: For the Total Occlusion task, there was no difference in looking time between the two types of drawers.

CONDITIONS 1, 2 AND 3 (FIRST DRAWING ONLY)

A 3 (age) x 3 (condition) x 2 (instruction) x 4 (look type) analysis of variance was performed in order to compare performance across the three drawing tasks. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

The ANOVA showed a main effect of age ($F(2,252)=63.18$ $p<.001$), in that the 4-year-olds spent less time looking at the model than the 6- and 8-year-olds (Scheffe $F(2,252)=76.01$ and 46.55 respectively, $ps<.001$) (mean seconds = 1.13, 2.34 and 2.11

TABLE 4.16 MEAN LOOKING TIME PER DRAWING REALISM AND AGE (NON-OCCLUSION TASK)

AGE	N	VISUAL REALISM	N	INTELLECTUAL REALISM	MEAN TOTAL
4 YEARS	4	0.24 (1.64)	45	0.18 (1.06)	**0.21** **(1.35)**
6 YEARS	20	0.29 (2.14)	36	0.27 (1.95)	**0.28** **(2.05)**
8 YEARS	45	0.30 (1.83)	12	0.22 (1.28)	**0.26** **(1.56)**
MEAN TOTAL		**0.28** **(1.87)**		**0.22** **(1.43)**	

Untransformed means (seconds) are shown in parentheses.

respectively). There was also a main effect of instruction ($F(1,252)=29.01$ $p<.001$), in that the explicit instructions led to increased attentional behaviour. See Table 4.17 for details of the means. These results therefore agreed with the results for Looking Time for Conditions 1 and 2, and the Number of Looks for Conditions 1, 2 and 3.

There was no significant main effect of condition ($F(2,252)=2.14$ $p>.05$), therefore looking behaviour did not vary across the three types of occlusion drawing. Condition did however interact with the instructions ($F(2,252)=3.67$ $p<.05$). Follow-up analysis of the means detailed in Table 4.17 revealed that the standard instructions produced significantly lower levels of looking than the explicit instructions for Condition 1 only i.e. the Non-Occlusion task (Scheffe $F(2,252)=23.27$ $p<.01$). See Figure 4.7 for an illustration of this effect. Therefore although the explicit instructions led to increased looking overall, this effect was more evident with the Non-Occlusion task. The Total Occlusion task seems to have produced high levels of looking irrespective of instructions.

The ANOVA showed a very highly significant main effect of look type ($F(3,665)=1361.83$ $p<.001^*$), as detailed in Table 4.18. Follow-up analysis revealed that more looks occurred at the 'beginning' compared to all other look types (Scheffe $ps<.001$), and fewer looks occurred at the 'end' of the task compared to all other look types (Scheffe $ps<.001$). This was therefore in agreement with the results for the Number of Looks measure, but in contrast with the analysis of Looking Time for Conditions 1 and 2 which revealed a significant difference between the 'between' and 'within' look types.

Table 4.18 also details the highly significant interaction between age and look type ($F(5,665)=13.87$ $p<.001^*$). This showed that all ages were looking more at the 'beginning' of the task compared to all other look types (Scheffe $ps<.001$), but the 8-year-olds were also looking less at the 'end' of the task compared to all other look types (Scheffe $ps<.01^*$). Although the 'end' look type showed no difference across age (Scheffe $ps>.05$), the 6- and 8-year-olds were looking more at the 'beginning' than the 4-year-

*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 4.17 MEAN LOOKING TIME PER INSTRUCTION AND CONDITION

CONDITION / INSTRUCTION	CONDITION 1 (NON-OCCLUSION)	CONDITION 2 (TOTAL OCCLUSION)	CONDITION 3 (PARTIAL OCCLUSION)	TOTAL MEAN
STANDARD	0.22 (1.32)	0.26 (1.69)	0.25 (1.69)	**0.24 (1.57)**
EXPLICIT	0.31 (2.43)	0.32 (2.20)	0.27 (1.82)	**0.30 (2.15)**
TOTAL MEAN	**0.27 (1.88)**	**0.29 (1.94)**	**0.26 (1.75)**	

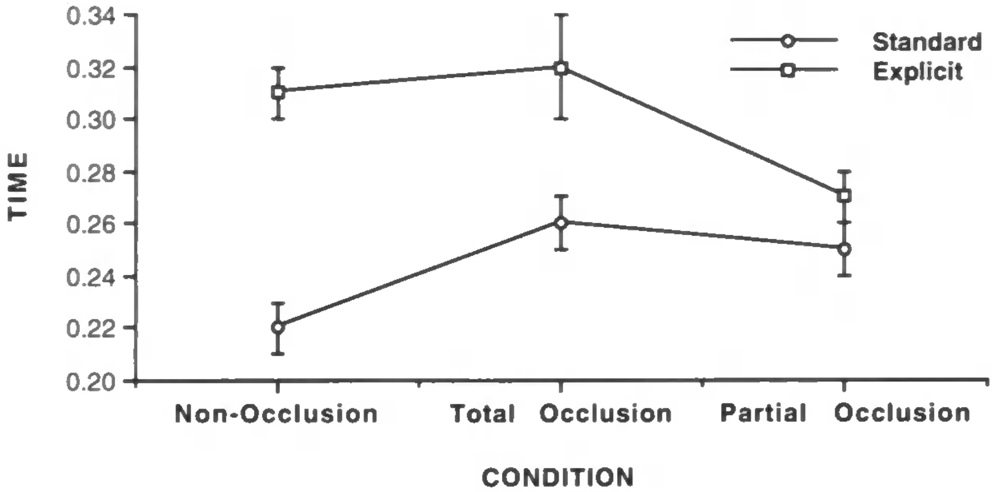
Untransformed means (seconds) are shown in parentheses.

TABLE 4.18 MEAN LOOKING TIME PER AGE, INSTRUCTION AND LOOK TYPE

AGE	N	BEGINNING	BETWEEN	WITHIN	END
4 YEARS	90	0.69 (4.28)	0.03 (0.10)	0.02 (0.06)	0.02 (0.07)
6 YEARS	90	0.93 (8.00)	0.14 (0.66)	0.09 (0.55)	0.05 (0.16)
8 YEARS	90	0.83 (6.26)	0.23 (0.94)	0.20 (1.06)	0.05 (0.17)
INSTRUCTION					
STANDARD	180	0.77 (5.38)	0.09 (0.32)	0.07 (0.44)	0.04 (0.12)
EXPLICIT	180	0.86 (6.97)	0.18 (0.81)	0.12 (0.67)	0.04 (0.15)
MEAN TOTAL		**0.81 (6.18)**	**0.13 (0.57)**	**0.10 (0.56)**	**0.04 (0.13)**

Untransformed means (seconds) are shown in parentheses.

FIGURE 4.7 INTERACTION OF CONDITION BY INSTRUCTION FOR LOOKING TIME MEASURE (CONDITIONS 1, 2 AND 3)



olds (Scheffe ps<.01), and the 8-year-olds were looking more 'within' and 'between' than the 4-year-olds (Scheffe ps<.001). Therefore the 8-year-olds were continuing to check their drawing with their view of the model in front of them.

Table 4.18 also details the means for the significant interaction between instruction and look type (F(3,665)=4.82 p<.01*). Follow-up analysis concluded that although both instructions led to more looking at the 'beginning' of the task (Scheffe ps<.001), it was only the explicit instructions that produced more looking 'between' than at the 'end' of the task (Scheffe F(3,665)=50.63 p<.001*). The 'beginning' looks as well as the 'between' looks produced significantly more looking with the explicit instructions compared to the standard instructions (Scheffe ps<.05).

Summary of Main Findings

1: The four-year-olds spent less time looking at the model than both the six- and eight-year-olds.

2: There was no difference in the time spent looking at the Non-Occlusion, Total Occlusion and Partial Occlusion models.

3: The explicit instructions led to higher levels of attention than the standard instructions, but only for Condition 1, and particularly at the 'beginning' of the task and 'between' drawing separate elements of the model.

4: More attention was paid to the model at the 'beginning' of the task, while the lowest levels of looking occurred at the 'end' of the task. The eight-year-olds however showed high levels of 'within' and 'between' looking.

LOOKING TIME AND DRAWING REALISM

A 3 (age) x 3 (condition) x 2 (realism) x 4 (look type) ANOVA was performed to compare the visually and intellectually realistic drawers across the three conditions, with a log(10) transformation again being performed.

*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

As detailed in Table 4.19, there was a main effect of drawing realism ($F(1,222)=5.02$ $p<.05$), in that the visually realistic drawers looked more than the intellectually realistic drawers. There was no interaction between drawing realism and age ($F(2,222)= 0.78$ $p>.05$) suggesting that increased looking for visually realistic drawers was evident for each age group.

Summary of Main Findings

1: The visually realistic drawers spent more time looking at the model than the intellectually realistic drawers, at all ages.

NUMBER OF LOOKS AND LOOKING TIME

In order to assess the relationship between the two measures of attention, Pearson Product Moment partial correlations were performed between each child's Number of Looks and Looking Time. Partial correlations were used in order to control for any possible age effects. These showed positive correlations of $r=0.68$, 0.69 and 0.71 (d.f.=177, 177 and 87 respectively, $ps<.001$) for the Non-Occlusion, Total Occlusion and Partial Occlusion drawings respectively.

TABLE 4.19 MEAN LOOKING TIME PER DRAWING REALISM AND AGE

AGE	N	VISUAL REALISM	N	INTELLECTUAL REALISM	MEAN TOTAL
4 YEARS	6	0.99 (1.78)	63	0.76 (1.13)	**0.87 (1.28)**
6 YEARS	30	1.25 (2.55)	54	1.18 (2.24)	**1.22 (2.32)**
8 YEARS	63	1.34 (2.16)	24	1.11 (1.81)	**1.23 (2.50)**
MEAN TOTAL		**1.20 (2.16)**		**1.02 (1.73)**	

Untransformed means (seconds) are shown in parentheses.

4.4 DISCUSSION

4.2.1 DRAWING DATA

The age-related changes in drawing realism for the Total and Non-Occlusion drawings did not reflect those reported in the previous two chapters. With the present study the four-year-olds were producing lower levels of visual realism than the six-year-olds, who in turn were producing lower levels than the eight-year-olds. Therefore there was a more gradual increase in drawing realism than those reported in the previous studies. These age differences were evident across both instructions and conditions, therefore the explicit instructions and the order of presentation did not have the hypothesised effects of increasing levels of visual realism. The age related changes for the Partial Occlusion task reflected those reported in Study 1 i.e. the four- and six-year-olds produced lower levels of visual realism than the eight-year-olds. This was consistent with the hypothesis that this task would be more difficult, which was also the case with the models presented in Study 1.

The four-year-olds did not show the high levels of apparent 'visual realism' detailed in Study 2. They were consistently intellectually realistic across all the three drawings irrespective of instructions or the order of presentation. The four-year-olds in Study 2 had a tendency to omit the hidden handle and just represented the body of the cup by drawing a circle, particularly with the standard instructions. Although this appeared to be a 'visually realistic' drawing of the Hidden Handle model, the children also replicated this drawing of a single circle for the Handle Visible task, which was neither intellectually nor visually realistic. They therefore seemed to be producing simplistic drawings. This was obviously not a problem with Study 3 because to draw the ball correctly only required a simple 'circle'. Being visually realistic involved correct placement, or omission of a second 'circle'. Therefore problems associated with the classification of intellectual or visual realism were eliminated.

Unlike Study 2, the four-year-olds in Conditions 1 and 2 did not show a consistent tendency to produce two identical drawings. However the majority of identical drawings in Study 2 were produced in response to the short exposure conditions. The continuous exposure conditions which were equivalent to Study 3's method, did not produce such high numbers of identical drawings. The present study did however show a higher proportion of identical drawings in Condition 2 when presented with the standard instructions. This condition presented the Total Occlusion model first, which led many children to incorrectly draw two separate balls (mainly horizontally). In response to the second Non-Occlusion task, the child this time correctly, produced a similar drawing of two separate balls. Children in Condition 1 with standard instructions showed a greater tendency to produce two non-identical drawings.

The research literature states that children of this age have an increased tendency to separate out two structurally separate objects that appear visually united. Therefore it was to be expected that, being presented with a Total Occlusion model first (Condition 2) under standard instructions, would possibly lead to a high proportion of 'separate' drawings. However when the Total Occlusion was presented second (Condition 1), the child saw the contrast between this and the initial Non-Occlusion model, and attempted to change their drawing in response to this. The fact that the different conditions and instructions had no effect on visual realism indicated that they were unsuccessful in producing a change to a visually realistic drawing, however a change from their first drawing was attempted (mainly a horizontal separate followed by a vertical separate). This effect was reduced by presenting the children with explicit instructions. Therefore the four-year-olds were showing instructional and presentation order effects, not with regard to the production of visually realistic drawings, but instead with regard to the production of identical drawings.

Like the four-year-olds, the eight-year-olds did not show any effects of instruction or order of presentation, however for the Total and Non-Occlusion models this age group produced significantly more visually realistic drawings. For the Partial Occlusion model no differences in the levels of the realism were noted. The attempt therefore to make the task more difficult was evident in the lack of significantly more visually realistic drawers for this latter drawing task. However it was still not sufficiently difficult to produce variations in performance across the two types of instructions.

For the Total and the Non-Occlusion drawings the six-year-olds showed no differences in the proportions of visual or intellectual realism at all. Unlike Study 2, there were equal proportions of both types of drawings, and the explicit instructions and order of presentation did not increase levels of visual realism. Although the Total Occlusion showed a trend towards increased levels of visual realism, the Non-Occlusion showed the opposite trend. The Non-Occlusion was assumed to be a simple task and yet visual realism levels did not reflect this. However to be visually realistic the two balls in the drawing needed to be touching, or at least very close together. Any evidence of separating out the two circles was classified as an intellectually realistic drawing. This was consistent with Cox (1981, Study 1) where they presented children with two funnels side by side. Their criteria for classification of intellectual realism was that the two funnels were drawn "quite separate" from each other.

The six-year-olds did show higher proportions of intellectual realism for the Partial Occlusion task. This was consistent with the hypothesis that this would be the more difficult task. The explicit instructions did not however increase the production of visual realism. This was therefore inconsistent with Barrett *et al.'s* (1985) findings that an age group ranging from six years six months to seven years six months showed significantly more partial occlusion drawings when presented with explicit instructions and the same drawing model as Study 3. However Study 3's age group ranged from five years six months to seven years three months, and therefore the younger children may have been masking any effects, especially as Barrett *et al.* found no instructional effect for a group aged five to six years. Although Lewis, Russell & Berridge (1993) did find that five-year-olds were affected by explicit instructions this was with a cup model. Also there were slight variations in instructions that could have accounted for the differing results. While Study 3's explicit instructions asked the children to "look very carefully at them so that you can draw exactly what you can see from where you are sitting", Barrett *et al.* asked "Please draw this for me exactly as you can see it from where you are sitting. Look very carefully at it so that you can draw it just as you see it". The latter therefore re-emphasises "as you see it". However the instructions used in Study 3 replicate exactly those used in Study 2, which did show highly significant instructional effects.

Study 2 detailed how the six-year-olds' drawing performance on the Handle Hidden task was affected by the instructions and order of presentation. The explicit instructions led to increased levels of visual realism irrespective of the order of presentation. The standard instructions only led to increased levels of visual realism if the child was first asked to draw the Handle Visible task. The order of presentation of the Non-Occlusion and Total Occlusion tasks in Study 3 had no effect at all on performance, despite the fact that they were designed to be equivalent to the Handle Visible and Handle Hidden tasks respectively. Therefore the contrast effect detailed above, and reported by Davis (1983) and Davis & Bentley (1984), seems to be applicable to single object drawings with the total and non-occlusion of a defining feature. The total and non-occlusion of a second identical object did not produce the same contrast effect.

The instructions did seem to have an effect on the six-year-olds' drawing performance when the three types of drawings were compared directly, although there were no significant effects at follow-up. For the Non-Occlusion task, the explicit instructions seem to have produced, as hypothesised, higher levels of visual realism than the standard instructions. The Partial Occlusion task seems to have produced low levels of visual realism irrespective of instructions, which was consistent with the hypothesis that this task would be more difficult. However the Total Occlusion task seems to have led to higher levels of visual realism overall but particularly with the standard instructions. This was therefore in opposition to the hypothesised instructional effect, and Study 2's results.

The Total Occlusion task possibly led to greater conflict with the child's reported tendency to draw both objects. There was obviously little conflict with the Non-Occlusion task as both objects were completely visible from the child's viewing position. For the Partial Occlusion the child still sees part of the second object and, as discussed earlier, this may have led them to believe they were still meant to draw the complete ball (Cox, 1991). However with the Total Occlusion model there was possibly direct conflict between this tendency and the child's view of just the one ball. Possibly the lower levels of attention associated with standard instructions meant that the child did not have time to consider this problem, and just drew their view. However the increased attention associated with the explicit instructions, may have led the child to spend time looking from side to side, or over the model at the second ball, and therefore led to production of an intellectually realistic 'separate' drawing.

4.4.2 ATTENTIONAL DATA

The age related changes in attentional behaviour for Study 3 reflected those reported in Study 2. The four-year-olds paid less attention to the model than the six- and eight-year-olds. This did not reflect the age changes in the development of visual realism for any of the three tasks. For the Total and Non-Occlusion task there was a significant increase between each age group, and for the Partial Occlusion task the four- and six-year-olds were more intellectually realistic than the eight-year-olds. Therefore the six-year-olds were paying as much attention to the models as the eight-year-olds but the drawing performance of these two age groups were significantly different. Therefore this age group may not be benefiting from their increased attention, or alternatively it is possible that the eight-year-olds were not attending to the models to any great extent due to the simplicity of the tasks.

The comparison of Conditions 1 and 2 showed that the explicit instructions increased levels of attention towards the model. This was therefore equivalent to the results reported in Study 2. However the two studies differed with regard to which look types were responsible for this effect. In Study 2 the main effect of instructions was generally associated with 'within' looking. However as hypothesised Study 3 produced low levels of 'within', and higher levels of 'between' looking. This was reflected in the fact that the increased levels of looking with the explicit instructions were generally produced by the 'beginning' and 'between' looks, and that the increased looking with age was generally associated with more 'between' looking.

Cups can vary quite considerably and therefore in order to produce an accurate drawing a child should continue to look at the model. However a ball is always round no matter what size it is. Therefore a child does not need to keep attending to the model in order to accurately represent its shape. However in order to accurately draw the whole model the child does need to attend to the second ball, in order to represent its correct location in relation to the first ball. This should result in increased levels of 'between' looking and reduced levels of 'within' looking. Therefore although the type of looking behaviour varied between the two studies the effect was the same. It was the explicit instructions that increased attention while the child was actually drawing, and it was the older children who were generally looking more while they drew.

The six-year-olds showed high levels of 'beginning' looking, and although this effect was only significant for the Looking Time measure for the analysis of Conditions 1 and 2, their means for this look type were consistently high across the different analyses and the two looking measures. This therefore reflects the results of Studies 1 and 2, and seems to suggest that these children have an awareness of the need to increase their attention towards the model in front of them, but are as yet unsure of the most effective way of carrying this out.

As reported in both Studies 1 and 2 there was a general reduction in attention from the first to the second drawing. Unlike Study 2 this main effect was only associated with the explicit instructions and the 'beginning' looks. As the explicit instructions increased attention at the 'beginning' of the task there was more opportunity for attention to decrease on the second task, while the standard instructions led to lower levels of attention to start with. Study 2 detailed how this drawing order effect was generally associated with 'within' looks, however Study 3 showed low levels of 'within' looking. Therefore, as the majority of attention towards the model occurred at the 'beginning' of the task it is not surprising that this effect was only associated with the 'beginning' looks.

Like Study 2, drawing order interacted with condition i.e. the order of presentation of the two models. With Study 2 the Handle Visible task retained the child's interest and did not produce a reduction in attention when presented second. In Study 3, the Non-Occlusion task was designed to be equivalent to the Handle Visible task. However it was the Total Occlusion task that retained the child's interest here. Study 2 discussed how this interaction may have been a measure of the contrast effect. If a child was only attending to the changed feature i.e. the handle, then they did not need to attend to any great extent if the handle went from being present to absent. However if the reverse order was presented the child not only needed to notice that the handle was now present, but also attend enough in order to draw it accurately. The Handle Visible task therefore retained the child's interest. With Study 3 the retained interest of the Total Occlusion model may also have been a measure of contrast, in that the child had already seen, and usually drawn, the two balls in the Non-Occlusion task. They were then shown the Total Occlusion task and were presented with the dilemma of whether to draw the two balls, or just draw the one ball that they could see. The decision process possibly took time and therefore increased attention. With the reverse order the child saw the Total Occlusion first and therefore had no previous model or drawing with which to compare this to.

Comparison of attention across the three types of occlusion drawings revealed that there were no overall differences between tasks. The hypothesis that the Partial Occlusion drawing would increase attention due to its reported difficulty, was not supported by the results. Instead it was the Total Occlusion task which produced a high level of looking. As discussed earlier it was this task which seems to have been a problem for the children, possibly due to cognitive conflict. This was illustrated further by the beneficial effect of the explicit instructions being associated, to a greater extent, with the Non-Occlusion task (for the Looking Time measure at least) than with the other two tasks, although they did show trends in the same direction. The explicit instructions therefore had the desired effect of increasing attention towards the model, particularly with the task that seems to have posed little cognitive problems for the child. When these cognitive problems arose i.e. the decision to retain their usual tendency to draw both objects and ignore their view (Total Occlusion task), the instructions did not have any effect i.e. attention levels were high for the standard instructions as well.

4.4.3 ATTENTION AND DRAWING REALISM

Relating these results of the children's attention to their drawing performance, showed that the four-year-olds were intellectually realistic and the eight-year-olds were visually realistic, irrespective of varying patterns of attention. However the six-year-olds did show slight variations in their drawing performance. Although they were generally intellectually realistic overall, they did show a trend towards increased levels of visual realism for the Total Occlusion task, more specifically with the standard instructions. This task seems to have been associated with the high levels of looking even with standard instructions. However it was discussed earlier that the standard instructions may have increased visual realism because low levels of attention led the child not to consider the problem of whether to ignore the second ball or not. However although the standard instructions did not show significantly lower levels of attention the trend was in the right direction. This task seems to have been cognitively complex but a visually realistic drawing of it was simple i.e. just a single circle. Standard instructions are usually associated with low levels of looking, however due to cognitive difficulty the looking behaviour was increased. Explicit instructions are usually associated with high levels of looking but if this is also associated with visual realism, a child will not have to attend to the model to any great extent in order to just draw the one ball. So the unusually high levels of looking for the standard, and low levels for the explicit instructions, seems to have resulted in the lack of significant difference between them.

In order to explore this more thoroughly, direct comparison of the looking behaviour of the intellectually and the visually realistic drawers was necessary. This showed that, for the Non-Occlusion and the Partial Occlusion tasks the visually realistic drawers were spending more time looking at the model than the intellectually realistic drawers, at all ages. This therefore confirmed the findings of Study 2.

For the Non-Occlusion task the levels of attention for the standard instructions were low, and low levels of looking were associated with intellectual realism. The explicit instructions led to high levels of attention and this was also associated with high levels of visual realism. Those children who looked less tended to be intellectually realistic possibly because they did not attend to the placement of the second ball next to the first one that they had drawn. Those children who looked more seemed to have considered this problem and therefore tended to produce visually realistic drawings. This was further confirmed by the fact that, the relationship between looking and drawing realism seems to have been associated with the 'between' looking, for the Number of Looks measure at least.

For the Partial Occlusion task, although the high levels of attention were associated with high levels of visual realism, the explicit instructions did not show increased levels of attention. However it was only the eight-year-olds who were visually realistic on this task. Separating out the instruction by condition interaction for each age group (see Appendix G, Table 10, Condition 3), showed that the four- and six-year-olds, who were generally intellectually realistic, showed little difference in attention between the two instructions. The eight-year-olds however, who showed increased levels of visual realism, did show a tendency to increase their looking with the explicit instructions. Therefore there was a relationship between visual realism and increased attention, but no relationship between explicit instructions and increased attention overall.

Unlike Study 2 and the other two tasks, the Total Occlusion model did not show variations in looking behaviour between the intellectually and visually realistic drawers, although the means showed trends in the right direction. Although the four-year-olds were generally intellectually realistic and looked less, and the eight-year-olds were generally visually realistic and looked more, the effect was possibly counteracted by the six-year-olds who were visually realistic but looked less. The less they looked the less time they possibly spent considering the dilemma this task posed, and just continued to draw the one ball that they could see. This could possibly account for the lack of relationship between visual realism and increased attention.

The Total Occlusion task, as discussed earlier, did not show any significant increase in attention with the explicit instructions. The attention levels for the standard instructions were moderately higher than expected, for the reasons detailed earlier. For the explicit instructions, although attention was slightly higher it was not significantly so. If the visually realistic child knows that they need to pay sufficient attention in order to draw this model, they would not need to spend much time attending because a visually realistic drawing only involved a single circle. A visually realistic drawing of the other two tasks involved the correct placement of the second circle in relation to the first one drawn. Similarly, with the Hidden Handle model in Study 2, although this only involved drawing the body of the cup, the visually realistic child should spend time drawing its exact shape. Therefore this could possibly account for the lack of overall instructional effect, and lack of relationship between increased attention and visual realism.

4.4.4 CONCLUSIONS

Therefore although the Total Occlusion model did not lead to the hypothesised effects in the same way as the other two models, the means were in the right direction. It is possible that significance was not reached due to the problems associated with the specific nature of this Total Occlusion task. In conclusion the explicit instructions do have the effect of increasing attention to the drawing model and this is generally associated with greater levels of visual realism. However it is suggested that the child who has an awareness of the need to look in order to be visually realistic, will modify their looking behaviour appropriately for the task.

The relationship between attention and drawing performance is beginning to be evident around six years of age, but is well established by eight years of age. These older children therefore continually attend to the model while they are drawing. Study 2 (Chapter 3) attempted to show how removing the opportunity for the children to continually attend to the model would reduce performance levels. However the task presented was too simple for the older children. Study 3 attempted to increase the difficulty by introducing a partial occlusion model that has been documented in the literature as being particularly difficult. However, although this led to reduced visual realism for the eight-year-olds, the model was not difficult enough to show variations in performance under the different instruction conditions. Therefore, in order to demonstrate a close relationship between the attention that the child pays to the drawing model and their subsequent ability to produce a visually realistic drawing, it would be necessary to increase the difficulty of the task further. If eight-year-old children, who are already visually realistic, can be made to produce an intellectually realistic drawing under these conditions, this would show a strong causal relationship between these two factors.

CHAPTER 5

STUDY 4
DETERIORATION OF THE EIGHT-YEAR-OLDS PERFORMANCE

5.1 INTRODUCTION

The relationship between attention paid towards the drawing model and visual realism has been demonstrated in the previous three studies. It seems that if children are aware of the necessity to pay attention to the model in order to be visually realistic, they will modify their behaviour according to the complexities of the task. It seems possible that this awareness begins to occur around six years of age. At this age the children's performance is greatly affected by the task demands. If presented with standard instructions as with Study 1, fairly even proportions of visually and intellectually realistic drawings are produced. However by presenting explicit instructions which prompt attention towards the model, as with Study 2, the proportion of visually realistic drawings increases. These instructions had the desired effect of increasing attention, particularly 'within' drawing a separate element of the model. The six-year-olds were therefore prompted into using a beneficial attentional strategy. As yet they do not spontaneously do this, although they do seem to show an increase in their 'beginning' looking even with the standard instructions (Study 1). It is possible that these children are aware of the need to increase their attention but are as yet unable to spontaneously employ the correct strategy. However, through the use of explicit instructions they can be prompted into doing so.

By the age of eight most children are capable of producing visually realistic drawings without the necessity of presenting them with explicit instructions. These children seem to be already aware of the most beneficial attentional strategy (continued attention to the model while drawing) and are able to employ this when necessary. If they are presented with simple tasks they seem to be able to produce a visually realistic drawing without extensive attention to the drawing model. However the more complex the task becomes, the more they use this attentional strategy in order to produce an accurate drawing of their view of the model. For example, in Study 1 the eight-year-olds showed high levels of 'within' and 'between' looking for Tasks 4 and 5, which had proved to be the most complex. This strategy was not necessary with the more simple models like Task 1.

Study 2 aimed to assess the importance of continued attention towards the model while the child was actually drawing, by denying them the opportunity to do so. Therefore the drawing model was removed once the instructions had been given. It was hoped that this would lead to a reduction in visual realism. Unfortunately the task turned out to be too simple and the eight-year-olds were able to accurately draw their view of the model even though they were only allowed to look at it before they started to draw. The results did however show a trend in the right direction, and it was concluded that a more complex model would be necessary in order to adequately assess whether limited exposure would deteriorate performance.

The present study therefore aimed to present eight-year-olds with either continuous or short exposure towards the two more complex models used in Study 1 i.e. Tasks 4 and 5. The children were presented with standard instructions due to this age group being generally unaffected by instructional variations (Barrett, Beaumont & Jennett, 1985) and Study 2), and in order to reflect the precedure used in Study 1. The order of the tasks was counterbalanced in order to control for any possible order effects.

The hypothesis for the drawing data was that:-

1: Short exposure to the drawing model would lead to an increase in intellectually realistic drawings.

The hypotheses for the attentional data were that:-

1: Short exposure would lead to a reduction in attention towards the model.

2: Visual realism would be associated with increased attention towards the model, particularly 'within' drawing a separate element of the model.

5.2 METHOD

5.2.1 SUBJECTS

Eighty children were randomly selected by the experimenter from the relevant classes at two Plymouth schools. The mean age was eight years (range 7:6 to 8:8 years, standard deviation 0:4 months). These children were randomly divided into four groups so that there were twenty children in each condition. There were forty males and forty females.

5.2.2 DESIGN

A 2 (exposure) x 2 (order) x 2 (task) design was conducted, with independent groups for the first two factors, and repeated measures for the third. The independent variables were exposure, order and task, and the dependent variables were, for the drawing data, classification of drawings as visually or intellectually realistic, and for the video data, the amount of attention the child paid towards the drawing model placed in front of them.

5.2.3 MATERIALS

Two plain white coffee mugs, with handles, measuring 9.5 cms. high and 8 cms. wide, were used as drawing models. These was placed on an inverted box measuring 26 cms. high in order to ensure presentation at eye-level. Plain A5 paper and a black pencil were given to the children to draw with.

5.2.4 PROCEDURE

Each child was tested individually by the same female experimenter in a private room at their school. Once rapport had been established, the child was asked to sit squarely at a table where the inverted box had been placed directly in front of them at a distance of 90 cms. from the child.

A video camera was angled to observe the child's direction of gaze and the drawing area in front of them. The experimenter tried not to draw too much attention towards the camera's presence in the room, by keeping contact with it to a minimum.

The child was given a plain piece of paper and a pencil. The experimenter said "I am going to ask you to do two drawings for me. Each time I want you to draw exactly what you can see from where you are sitting". The model was then placed in front of the child on top of the box. The experimenter said "Here are two cups. Please draw exactly what you can see from where you are sitting". Once completed the child was given another piece of paper, the second model was then positioned and the instructions repeated. The child either saw Task 1 followed by Task 2 (Order 1/2) or the reverse (Order 2/1).

Task 1 consisted of the front cup being placed with its handle turned to the right. The second cup was placed directly behind the first but with its handle turned to the left. The child's view was therefore of one cup with two handles or a 'baby cup'. This was therefore equivalent to Task 4 in Study 1.

Task 2 consisted of the front cup being placed with its handle turned to the right. The second cup was placed behind but slightly to the left of the front cup and was therefore partially occluded. The handle of the back cup was turned to the right and therefore totally occluded by the front cup. This was therefore equivalent to Task 5 in Study 1.

If the child was unsure of what (s)he was required to do the instructions were repeated. The children were given as long as they required to complete each drawing. Each child was praised for their drawings and thanked for their help.

5.2.5 SCORING

DRAWING DATA

Each child's two drawings were classified into one of four categories i.e. visually realistic, intellectually realistic, omission or miscellaneous.

1: A visually realistic drawing consisted of only those elements of the model that could be seen from the child's viewing position. For Task 1 partial occlusions showing part of the back cup with a shared boundary of the front cup were also included. This was due to the problem associated with the child moving their head from side to side, or looking over the model, and therefore seeing a slightly different view to the one intended. The model was placed as far away from the child as possible in order to reduce this problem.

2: An intellectually realistic drawing either contained features that were not visible, separate discrete objects that were visually united in the model, or transparencies.

3: Omission drawings omitted features that were visible.

4: Drawings that could not be reliably classified by these criteria were classified as miscellaneous.

Examples of these four types of drawings obtained in each task are shown in Table 5.1.

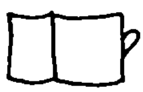
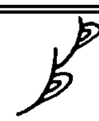
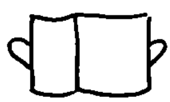
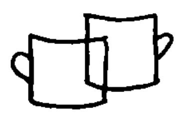
In order to establish inter-judge reliability 10% of the subjects were randomly selected from each of the two exposure conditions, and their drawings were re-classified by a second independent judge. Classification showed a 100% agreement. The Kappa statistic [for assessment of categorical data (Siegel & Castellan, 1988)] showed perfect agreement between judges which was found to be significantly different from zero ($K=1.00$, $Z=1.73$ $p<.05$). The classifications of the first judge were used in the subsequent analyses.

ATTENTIONAL DATA

Each child's attention towards the model in front of them was scored in two ways. Firstly the number of looks and secondly the time spent looking at the model. These two measures were divided into the Number of Looks or Looking Time at the 'beginning' of the task before drawing commenced; 'between' drawing separate elements of the model; 'within' drawing a particular element and at the 'end' of the task after the drawing had been completed.

In order to establish intra-observer reliability 10% of the subjects were randomly selected from the short exposure conditions, and 10% from the continuous exposure conditions, and their attention was re-assessed. This was to ensure that there was enough data to analysis the reliability of classification of the 'between', 'within' and 'end' look types, which only occurred with continuous exposure to the model. Pearson Product

TABLE 5.1 CLASSIFICATION OF DRAWINGS

TASK	VISUAL REALISM	INTELLECTUAL REALISM	OMISSION	MISCEL-LANEOUS
1		† 		
	* 	* * 		
		† 		
				
2		† 		
		* * * 		
		† 		
				

* Classified as visually realistic due to shared boundary.

* * Classified as intellectually realistic as separates the handle that belongs to the back cup.

* * * Classified as intellectually realistic as included the hidden handle.

† With or without handle(s).

Moment correlations were used to compare the relationship between the first and second assessments, separately for each measure. There were a high number of zero scores due to some subjects only looking at the 'beginning' of the task. It was felt that inclusion of these scores would adversely affect the analyses. The correlation on the remaining data showed strong relationships for both the Number of Looks and Looking Time measures ($r=0.96$ and 0.98 respectively, $d.f.=61$, $ps<.001$).

Due to the zero scores being omitted from the correlation, intra-observer reliability of classification of attention into the four look types was assessed using the Phi Coefficient [for use with nominal data (Siegel & Castellan, 1988)]. There was a 96% agreement overall, which represented highly significant associations of $r_{\phi}=1.00$ for the 'beginning' look type, and $r_{\phi}=0.76$ for each of the 'between', 'within' and 'end' look types. These scores were shown to be significantly different from zero ($X^2 = 15.75$ $p<.001$ and 4.41 $p<.05$ respectively).

The reliability of the attentional data was conducted on an intra-observer basis due to the scoring of the children's attention being a lengthy and complex procedure.

5.2.6 DATA ANALYSIS

DRAWING DATA

The proportions of children producing intellectually and visually realistic drawings were analysed using Log-Linear Modelling. This allows analysis of frequency data from two or more independent groups, to be assessed across two or more discrete categorical variables, therefore incorporating interaction effects. Full details of this procedure are given in Appendix C.

Where more than twenty percent of the expected cell frequencies were less than five the Chi-Square test for independent samples was used. This allows for analysis of just one categorical variable at any one time. Where the observed set of frequencies formed a 2 x 2 contingency table, the Yates correction for continuity was applied (Siegel & Castellan, 1988). If any of these expected cell frequencies were less than five the Fisher Exact Probability test was used.

ATTENTIONAL DATA

Analysis of Variance (ANOVA) was used to assess the amount of attention paid towards the drawing model. Where the assumption of homogeneity of variance between conditions was not met, transformations were performed on the raw data according to the criteria detailed in Howell (1987). Significant differences were assessed using Scheffe's method of multiple comparison of means (See Appendix A for full details).

5.3 RESULTS

5.3.1 DRAWING DATA

The number of children in each condition producing the five types of drawings are detailed in Table 5.2. Only those children producing either visually or intellectually realistic drawings were included in the following analyses. Where the analysis was computed using Log-Linear Modelling, full tables showing the Likelihood Ratios for Chi-square Change for each model tested and the standardised residuals (i.e. the difference between observed and the expected frequencies based on the selected model) are detailed in Appendix H. Full details of the Log-Linear Modelling procedure are given in Appendix C.

TASK 1

Fisher Exact Probability tests were used to assess the effects of exposure and task order on the children's drawing performance for this task. This showed that there was a significant effect of exposure but a non-significant effect of order (Fisher Exact Test $p<.01$ and $p>.05$ respectively). The short exposure condition therefore led to a reduction in performance compared to the continuous exposure. The 1/2 and 2/1 task orders produced similar performance levels.

TASK 2

Log-Linear Modelling was used to analyse the frequency of intellectually and visually realistic drawings for this task. Separating out the observed frequencies for both exposure and task order resulted in more than the required 20% of expected cell frequencies being less than five. The observed frequencies were therefore initially combined across exposure and then combined across order.

Backward elimination of this first Log-Linear Model resulted in only the effect of drawing realism being sufficient to explain the observed frequencies. The Likelihood Ratio for Chi-Square Change for removal of this factor was highly significant ($X^2=23.86$ d.f.=1

TABLE 5.2 FREQUENCY OF DRAWINGS IN EACH CONDITION

		TASK 1				TASK 2			
EXPOSURE/ ORDER	**N**	**V.R. †**	**I.R. †**	**OMISSION**	**MISCELLANEOUS**	**V.R. †**	**I.R. †**	**OMISSION**	**MISCELLANEOUS**
CONTINUOUS									
1/2 Order	20	19	1	0	0	19	1	0	0
2/1 Order	20	20	0	0	0	17	2	1	0
TOTAL		**39**	**1**	**0**	**0**	**36**	**3**	**1**	**0**
SHORT									
1/2 Order	20	16	1	2	1	14	5	0	1
2/1 Order	20	13	7	0	0	10	10	0	0
TOTAL		**29**	**8**	**2**	**1**	**24**	**15**	**0**	**1**

† V.R. = Visually Realistic I.R. = Intellectually Realistic

p<.001). As can be seen from Table 5.3 both orders produced high proportions of visually realistic drawers.

Backward elimination of the other Log-Linear Model resulted in an interaction between exposure and drawing realism being sufficient to explain the observed frequencies. The Likelihood Ratio for Chi-Square Change for removal of this interaction was highly significant (X^2=11.15 d.f.=1 p<.001). Table 5.4 details the observed frequencies and the summary of the follow-up analysis for this interaction. This showed that the short exposure condition led to an increased proportion of intellectually realistic drawings (denoted by the significant positive lambda value), and a reduced proportion of visually realistic drawings (denoted by the significant negative lambda value). The short exposure therefore had to desired effect of reducing the eight-year-olds performance.

COMPARISON ACROSS TASKS

Comparison of the children's performance across tasks showed no significant differences (Fisher Exact Test ps>.05). The majority of children (70%) were visually realistic on both tasks. The one condition that did produce a high number (n=10) of intellectually realistic drawings for Task 2 (short exposure, 2/1 order), subsequently led to 5 of these subjects being intellectually realistic on Task 1, while the remaining 5 were visually realistic on Task 1. Therefore even this condition only led to 5 subjects being intellectually realistic on both tasks.

Summary of Main Findings

1: There were no significant differences in performance across the two task orders.

2: The short exposure condition reduced performance on both tasks.

3: The majority of children were visually realistic on both tasks.

5.3.2 ATTENTIONAL DATA

The following sections detail the main findings of the attentional analysis. The full analysis of variance summary tables and details of the subsidiary results are given in Appendix I.

TABLE 5.3 OBSERVED FREQUENCIES FOR THE DRAWING REALISM BY TASK ORDER INTERACTION (TASK 2)

ORDER	VISUAL REALISM	INTELLECTUAL REALISM	TOTAL
TASK 1/TASK 2	32	6	38
TASK 2/TASK 1	28	12	40
TOTAL	60	18	

TABLE 5.4 OBSERVED FREQUENCIES AND FOLLOW-UP ANALYSIS FOR THE EXPOSURE BY DRAWING REALISM INTERACTION (TASK 2)

	VISUAL REALISM			INTELLECTUAL REALISM		
EXPOSURE	Observed Frequency	Lambda	Z Test *	Observed Frequency	Lambda	Z Test *
Continuous	36	+0.50	+2.92	3	-0.50	-2.92
Short	24	-0.50	-2.92	15	+0.50	+2.92
TOTAL	60	0.00	0.00	18	0.00	0.00

* Z scores greater than or equal to 1.96 (+ or -) are significant at p<.05.

5.3.2.1 NUMBER OF LOOKS

CONTINUOUS AND SHORT EXPOSURES

As the short exposure only allowed for looking at the 'beginning' of the task, there was no factor of look type for these conditions. Therefore in order to compare the continuous and short exposures a 2 (exposure) x 2 (task order) x 2 (drawing order) analysis of variance was performed on the total number of times each child looked at the model in front to them. The four look types were therefore combined with the continuous exposure conditions. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

This showed a highly significant main effect of exposure ($F(1,76)=233.90$ $p<.001$) where predictably the continuous exposure led to an increased number of looks. There was no significant main effect of task order ($F(1,76)=0.30$ $p>.05$) indicating that the two orders (1/2 and 2/1) led to similar levels of looking overall. There was however a main effect of drawing order ($F(1,76)=33.05$ $p<.001$) where more looks occurred on the first drawing irrespective of which task this was.

Drawing order significantly interacted with exposure ($F(1,76)=4.24$ $p<.05$). See Table 5.5 for details of these means. Scheffe's follow-up analysis showed that the main effect of drawing order was only evident with the continuous exposure conditions (Scheffe $F(1,76)=30.26$ $p<.001$). The short exposure conditions did not show a significant reduction in attention between the first and second drawing model (Scheffe $F(1,76)=8.77$ $p>.05$).

Drawing order also interacted with task order ($F(1,76)=19.16$ $p<.001$). As shown in Table 5.6, the main effect of drawing order was produced by the 2/1 task order and not the 1/2 task order (Scheffe $F(1,76)=51.75$ $p<.001$). Task 2 therefore led to increased attention when presented first.

Task order and drawing order also significantly interacted with exposure ($F(1,76)=11.05$ $p<.01$). This showed that the above detailed interaction between drawing order and task

TABLE 5.5 MEAN NUMBER OF LOOKS PER EXPOSURE AND DRAWING ORDER

EXPOSURE DRAWING ORDER	N	CONTINUOUS	SHORT	MEAN TOTAL
FIRST DRAWING	80	0.93 (8.75)	0.40 (1.55)	**0.66** **(5.15)**
SECOND DRAWING	80	0.80 (5.93)	0.33 (1.20)	**0.57** **(3.56)**
MEAN TOTAL		**0.86** **(7.34)**	**0.37** **(1.38)**	

Untransformed means (number of looks) are shown in parentheses.

TABLE 5.6 MEAN NUMBER OF LOOKS PER TASK ORDER AND DRAWING ORDER

TASK ORDER DRAWING ORDER	N	1 / 2	2 / 1	MEAN TOTAL
FIRST DRAWING	80	0.62 (4.33)	0.71 (5.98)	**0.66** **(5.15)**
SECOND DRAWING	80	0.59 (3.90)	0.54 (3.23)	**0.57** **(3.56)**
MEAN TOTAL		**0.61** **(4.12)**	**0.63** **(4.61)**	

Untransformed means (number of looks) are shown in parentheses.

order was only evident with the continuous exposure (Scheffe $F(1,76)=60.52$ $p<.01$). Therefore with continuous exposure to the drawing model, Task 2 produced a high level of looking when it was presented first. See Table 5.7 and Figure 5.1 for further details.

Summary of Main Findings

1: There was no difference in the frequency of looking between the two task orders.

2: The continuous exposure led to a higher frequency of looking than the short exposure.

3: A greater frequency of looking was also evident with the first model presented, particularly when Task 2 preceded Task 1 and with continuous exposure.

NUMBER OF LOOKS AND DRAWING REALISM

When comparing intellectually and visually realistic drawers with regard to their number of looks, it was not possible to distinguish between task orders due to a lack of intellectually realistic drawers in some order conditions. However two 2 (exposure) x 2 (drawing realism) analyses of variance were performed, one for each drawing task. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed.

This showed that neither task produced a significant main effect of drawing realism ($ps>.05$). However there were low subject numbers, in particular there were only three intellectually realistic children in the continuous exposure conditions.

Task 2 did however show a significant interaction between drawing realism and exposure ($F(1,74)=8.46$ $p<.01$). Follow-up analysis of the means detailed in Table 5.8, revealed that it was the visually realistic drawers alone who accounted for the significant exposure effect (Scheffe $F(1,74)=223.64$ $p<.001$). As illustrated in Figure 5.2, the visually realistic drawers were therefore looking more when they had the opportunity to do so.

Summary of Main Findings

1: For Task 2, the visually realistic drawers showed a higher frequency of looking with

TABLE 5.7 MEAN NUMBER OF LOOKS PER TASK ORDER, DRAWING ORDER AND EXPOSURE

EXPOSURE	CONTINUOUS		SHORT		MEAN TOTAL
TASK ORDER	1 / 2	2 / 1	1 / 2	2 / 1	
DRAWING ORDER					
FIRST	0.85 (7.15)	1.01 (10.35)	0.39 (1.50)	0.40 (1.60)	**0.66 (5.15)**
SECOND	0.84 (6.55)	0.75 (5.30)	0.35 (1.25)	0.32 (1.15)	**0.37 (3.56)**
MEAN TOTAL	**0.84 (6.85)**	**0.88 (7.83)**	**0.37 (1.38)**	**0.36 (1.38)**	

Untransformed means (number of looks) are shown in parentheses.

TABLE 5.8 MEAN NUMBER OF LOOKS PER EXPOSURE AND DRAWING REALISM (TASK 2)

EXPOSURE DRAWING REALISM	N	CONTINUOUS	SHORT	MEAN TOTAL
VISUAL	60	0.94 (11.55)	0.34 (4.29)	**0.64 (7.92)**
INTELLECTUAL	18	0.70 (6.66)	0.40 (4.28)	**0.55 (5.47)**
MEAN TOTAL		**0.82 (9.11)**	**0.37 (4.28)**	

Untransformed means (number of looks) are shown in parentheses.

FIGURE 5.1 INTERACTION OF DRAWING ORDER BY TASK ORDER BY EXPOSURE FOR THE NUMBER OF LOOKS MEASURE (CONTINUOUS AND SHORT EXPOSURES)

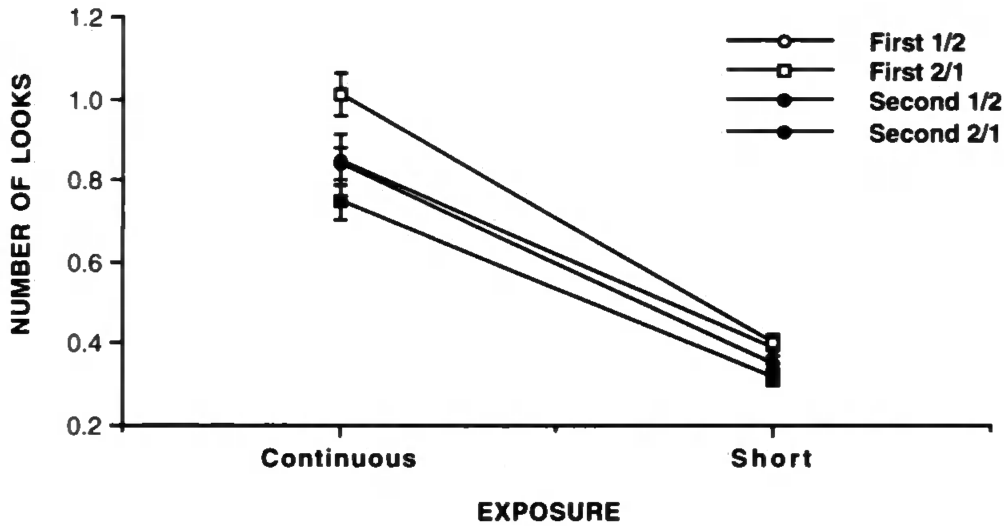
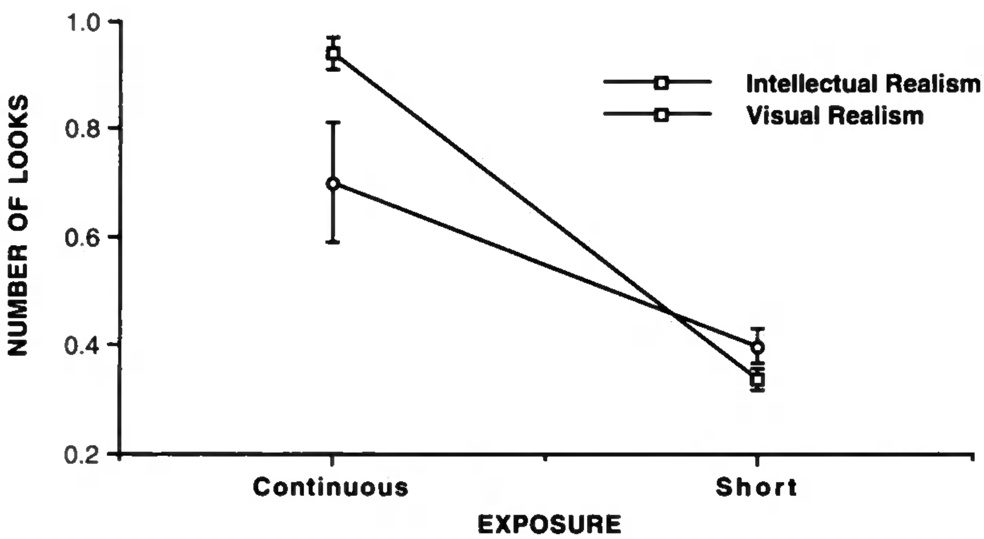


FIGURE 5.2 TASK 2 - INTERACTION OF DRAWING REALISM BY EXPOSURE FOR THE NUMBER OF LOOKS MEASURE (CONTINUOUS AND SHORT EXPOSURES)



the continuous exposure condition.

2: Task 1 showed no significant differences between the two types of drawers.

CONTINUOUS EXPOSURE

In order to assess the effects of the four look types (i.e. looking at the 'beginning' of the task; 'between' drawing separate elements of the model; 'within' drawing one element and looking at the 'end' of the task), only the two continuous exposure conditions were available for analysis. Therefore a 2 (task order) x 2 (drawing order) x 4 (look type) analysis of variance was performed. Due to unequal variances and these variances being proportional to the means, a square root transformation was used.

This showed a non-significant main effect of task order ($F(1,38)=0.33$ $p>.05$). Therefore like the analysis of the total number of looks, both task orders led to similar levels of looking overall. The ANOVA also showed a highly significant main effect of drawing order ($F(1,38)=104.36$ $p>.001$), where more looking occurred on the first task presented to the child irrespective of which task this was.

This analysis showed a significant main effect of look type ($F(3,99)=13.42$ $p<.001$*), where the 'within' looks were greater than all other look types, and the 'end' looks were lower than all other look types (Scheffe ps<.001). This factor significantly interacted with task order ($F(3,99)=6.96$ $p<.001$*), and showed that although the 2/1 task order showed the same pattern of results as the main effect (Scheffe ps<.01), the 1/2 order only showed that the 'end' looks were significantly lower than the other three look types (Scheffe ps<.001). As can be seen from Table 5.9, the 2/1 task order seems to have led to an increased frequency of 'within' looking.

Summary of Main Findings

1: There was no difference in the frequency of looking between the two task orders.

2: There was a greater frequency of looking towards the first model, particularly when Task 2 preceded Task 1.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 5.9 MEAN NUMBER OF LOOKS PER TASK ORDER AND LOOK TYPE

TASK ORDER	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
1 / 2	40	1.63 (1.73)	1.72 (2.10)	1.85 (2.75)	1.11 (0.28)	**1.58 (1.72)**
2 / 1	40	1.67 (1.88)	1.65 (1.90)	2.06 (3.80)	1.10 (0.25)	**1.62 (1.96)**
MEAN TOTAL		**1.65 (1.81)**	**1.69 (2.00)**	**1.96 (3.28)**	**1.11 (0.27)**	

Untransformed means (number of looks) are shown in parentheses.

3: There was a high level of 'within' looking, particularly for the 2/1 task order.

NUMBER OF LOOKS AND DRAWING REALISM

When comparing intellectually and visually realistic drawers with regard to their number of looks, it was again not possible to distinguish between task orders. However two 2 (drawing realism) x 4 (look type) analyses of variance were performed, one for each drawing task. Due to unequal variances and these variances being proportional to the means, a square root transformation was performed.

Neither task produced a significant main effect of drawing realism, although Task 2 did approach significance ($F(1,37)=4.05$ $p=.05$), although it must be noted that there were only three intellectually realistic drawers.

Task 2 did however show a significant interaction between drawing realism and look type ($F(2,79)=5.05$ $p<.01$*). Follow-up analysis of the means detailed in Table 5.10, showed that the visually realistic drawers looked significantly more 'within' than at the 'beginning' of the task, and looked less at the 'end' of the task compared to all other look types (Scheffe ps<.05). The intellectually realistic drawers showed no significant differences between any of the four look types, however the subject numbers were very low. See Figure 5.3 for an illustration of this effect.

Summary of Main Findings

1: The visually realistic drawers showed high levels of 'within' looking for Task 2.

5.3.2.2 LOOKING TIME

CONTINUOUS AND SHORT EXPOSURES

As the short exposure only allowed for looking at the 'beginning' of the task, there was no factor of look type for these conditions. Therefore in order to compare the continuous and

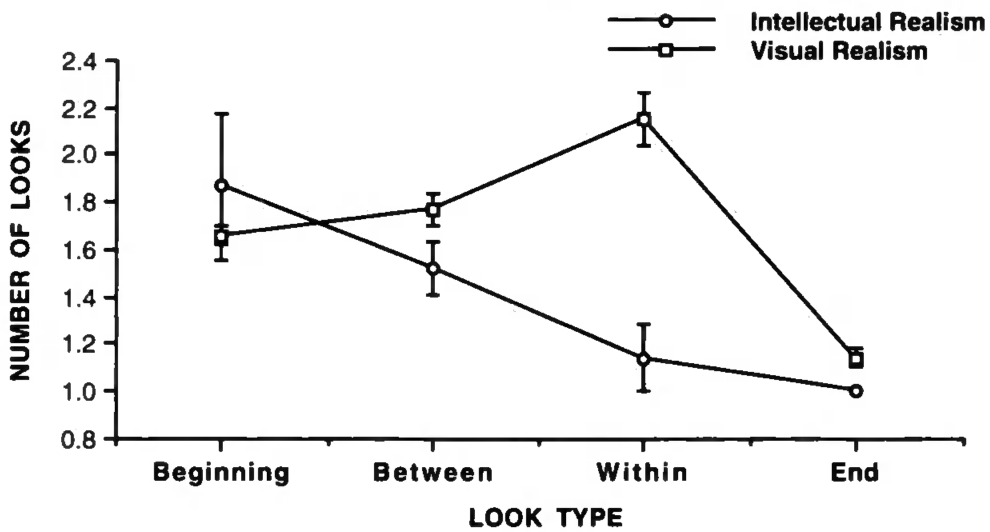
* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 5.10 MEAN NUMBER OF LOOKS PER LOOK TYPE AND DRAWING REALISM (TASK 2)

REALISM	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
Visual	36	1.66 (1.83)	1.77 (2.30)	2.15 (4.03)	1.14 (0.36)	**1.68 (2.13)**
Intellectual	3	1.87 (2.67)	1.52 (1.33)	1.14 (0.33)	1.00 (0.00)	**1.38 (1.08)**
MEAN TOTAL		**1.68 (1.90)**	**1.75 (2.23)**	**2.07 (3.74)**	**1.14 (0.33)**	

Untransformed means (number of looks) are shown in parentheses.

FIGURE 5.3 INTERACTION OF DRAWING REALISM BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE (CONTINUOUS EXPOSURE)



short exposures a 2 (exposure) x 2 (task order) x 2 (drawing order) analysis of variance was performed on each child's total looking time. The four look types were therefore combined with the continuous exposure conditions. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

This showed a highly significant main effect of exposure ($F(1,76)=109.83$ $p<.001$) where predictably the continuous exposure led to increased looking time. There was no significant main effect of task order ($F(1,76)=0.04$ $p>.05$) indicating that the two orders (1/2 and 2/1) led to similar levels of looking overall. There was however a main effect of drawing order ($F(1,76)=50.30$ $p<.001$), where more looking occurred on the first drawing irrespective of which task this was.

Drawing order significantly interacted with exposure ($F(1,76)=4.11$ $p<.05$). See Table 5.11 for details of these means. Follow-up analysis showed that the main effect of drawing order was only evident with the continuous exposure conditions (Scheffe $F(1,76)=41.12$ $p<.001$). The short exposure conditions did not show a significant reduction in attention between the first and second drawing model (Scheffe $F(1,76)=11.92$ $p>.05$).

Summary of Main Findings

1: There was no difference in looking time between the two task orders.

2: The continuous exposure led to the children spending more time looking at the model than the short exposure.

3: More attention was paid to the first model irrespective of which model this was, particularly for the continuous exposure.

LOOKING TIME AND DRAWING REALISM

When comparing intellectually and visually realistic drawers with regard to their looking time, it was again not possible to distinguish between task orders. However two 2 (exposure) x 2 (drawing realism) analyses of variance were performed, one for each

TABLE 5.11 MEAN LOOKING TIME PER EXPOSURE AND DRAWING ORDER

EXPOSURE DRAWING ORDER	N	CONTINUOUS	SHORT	MEAN TOTAL
FIRST DRAWING	80	1.11 (13.02)	0.76 (4.98)	0.93 (8.95)
SECOND DRAWING	80	0.98 (9.29)	0.69 (4.01)	0.83 (6.65)
MEAN TOTAL		1.04 (11.16)	0.72 (4.50)	

Untransformed means are shown in parentheses.

drawing task. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed.

Neither task produced a significant main effect of drawing realism (ps>.05). However there were low subject numbers, in particular there were only three intellectually realistic children in the continuous exposure conditions. Unlike the results for the Number of Looks measure, there were no significant interactions between drawing realism and exposure.

Summary of Main Finding

1: There were no significant differences in looking behaviour between the intellectually and visually realistic drawers.

CONTINUOUS EXPOSURE

In order to assess the effects of the four look types (i.e. looking at the 'beginning' of the task; 'between' drawing separate elements of the model; 'within' drawing one element and looking at the 'end' of the task), only the two continuous exposure conditions were available for analysis. Therefore a 2 (task order) x 2 (drawing order) x 4 (look type) analysis of variance was performed. Due to unequal variances and these variances being proportional to the means, a square root transformation was used.

This showed a non-significant main effect of task order ($F(1,38)=0.48$ $p>.05$). Therefore like the analysis of the total looking time, both task orders led to similar levels of looking overall. There was however a highly significant main effect of drawing order ($F(1,38)=$ 223.98 $p>.001$), where more looking occurred on the first task presented to the child irrespective of which task this was.

This analysis showed a significant main effect of look type ($F(2,85)=67.99$ $p<.001$*),

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

where the 'beginning' looks were greater than all other look types, the 'within' looks were greater than the 'between' and 'end' look types, and the 'end' looks were lower than all other look types (Scheffe ps<.001). This factor significantly interacted with task order ($F(2,85)=3.39$ $p<.05$*), and showed that the 2/1 task order led to increased 'within' looking in that it was not significantly different from the 'beginning' looks (Scheffe $F(2,85)=12.85$ $p>.05$*). The 1/2 task order however showed these two look types to be significantly different from each other (Scheffe $F(2,85)=42.72$ $p<.01$*). See Table 5.12 for details of the means and Figure 5.4 for an illustration of this effect.

Summary of Main Findings

1: There was no difference in the time spent looking at the models between the two task orders.

2: More attention was paid to the first model irrespective of which model this was.

3: The highest levels of attention were paid at the 'beginning' of the task and 'within' drawing a separate element of the model. The increased 'within' looking was particularly evident when Task 2 preceded Task 1.

LOOKING TIME AND DRAWING REALISM

When comparing intellectually and visually realistic drawers with regard to their looking time, it was again not possible to distinguish between task orders. However two 2 (drawing realism) x 4 (look type) analyses of variance were performed, one for each drawing task. Due to unequal variances and these variances being proportional to the means, a square root transformation was performed.

This showed that neither task produced a significant main effect of drawing realism, although Task 2 approached significance ($F(1,37)=3.10$ $p=.08$), although it must be reiterated that there were only three intellectually realistic drawers. See Table 5.13 for details of these means.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 5.12 **MEAN LOOKING TIME PER TASK ORDER AND LOOK TYPE**

TASK ORDER	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
1 / 2	40	2.41 (4.97)	1.73 (2.17)	1.90 (3.00)	1.11 (0.27)	**1.79 (2.60)**
2 / 1	40	2.43 (5.15)	1.71 (2.16)	2.15 (4.32)	1.09 (0.25)	**1.85 (2.97)**
MEAN TOTAL		**2.42 (5.06)**	**1.72 (2.17)**	**2.02 (3.66)**	**1.10 (0.26)**	

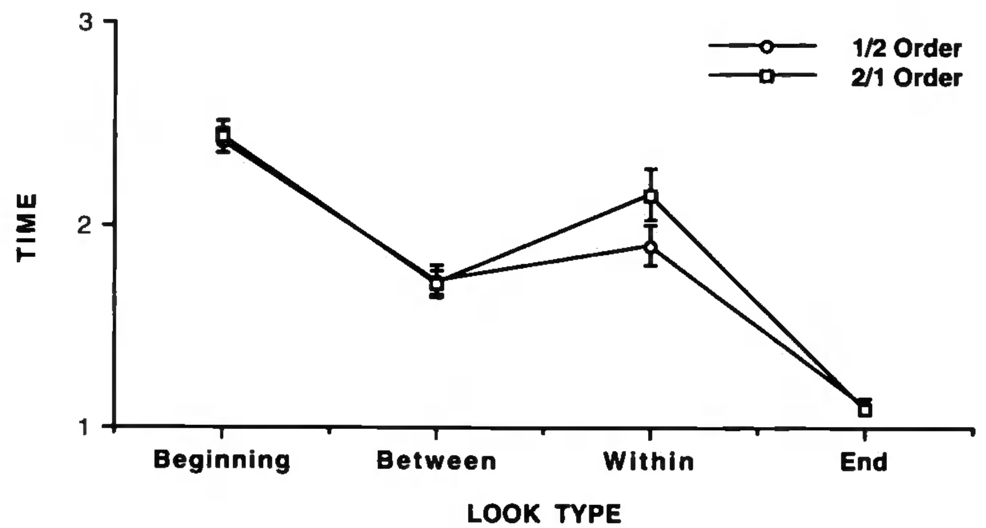
Untransformed means (seconds) are shown in parentheses.

TABLE 5.13 **MEAN LOOKING TIME PER LOOK TYPE AND DRAWING REALISM (TASK 2)**

REALISM	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
Visual	36	2.32 (4.53)	1.78 (2.37)	2.18 (4.29)	1.14 (0.36)	**1.68 (2.89)**
Intellectual	3	2.38 (4.92)	1.45 (1.12)	1.23 (0.62)	1.00 (0.00)	**1.38 (1.67)**
MEAN TOTAL		**2.32 (4.56)**	**1.76 (2.27)**	**2.11 (4.01)**	**1.13 (0.33)**	

Untransformed means (seconds) are shown in parentheses.

FIGURE 5.4 **INTERACTION OF TASK ORDER BY LOOK TYPE FOR LOOKING TIME MEASURE (CONTINUOUS EXPOSURE)**



Task 2 did however show a significant interaction between drawing realism and look type ($F(3,111)=2.92$ $p<.05$) although with the Epsilon correction the effect was non-significant. However follow-up analysis of the means detailed in Table 5.13, did show that the visually realistic drawers looked significantly more at the 'beginning' than 'between' drawing separate elements of the model (Scheffe $F(2,82)=28.76$ $p<.05^*$). The intellectually realistic drawers showed no significant differences between their look types (Scheffe ps>.05), however subject numbers were very low. See Figure 5.5 for an illustration of this effect.

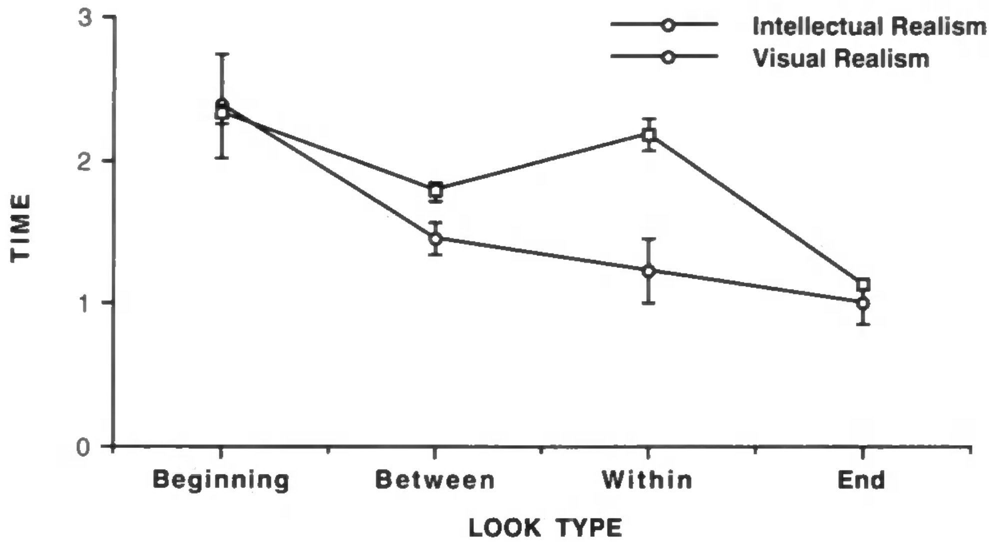
Summary of Main Findings

1: The visually realistic drawers showed a trend towards high levels of 'within' looking for Task 2.

NUMBER OF LOOKS AND LOOKING TIME

In order to assess the relationship between the two measures of attention, Pearson Product Moment correlations were performed on each child's Number of Looks and Looking Time. These showed positive correlations of $r=0.87$ and 0.91 (d.f.=78 $ps<.001$) for Tasks 1 and 2 respectively.

FIGURE 5.5 TASK 2 - INTERACTION OF DRAWING REALISM BY LOOK TYPE FOR LOOKING TIME MEASURE (CONTINUOUS EXPOSURE)



5.4 DISCUSSION

Study 2 hypothesised that short exposure to the model would reduce eight-year-olds ability to produce visually realistic drawings. However the task was quite simple and no significant effects were found. In order to alleviate this problem, the present study presented two models used in Study 1 that had been shown to be fairly complex, i.e. they had produced the longest and most strategic patterns of attention. With both of these models the eight-year-olds showed a significant reduction in performance when they were only allowed to attend to the model before they started to draw. The effect was however more marked with Task 2. This therefore provided a clear indication of the importance of continued attention towards the model while the child is drawing.

Unlike Studies 1 and 2 there was no significant effect of task order. However with these previous studies the differences between the tasks related to the presence or absence of the handle. With standard instructions, prior exposure to a model where the handle is visible is necessary to produce visual realism of a model where the handle is hidden from view. However with the present study both tasks had visible handles. Although it was possible that seeing Task 1 could aid performance on Task 2, due to Task 1 having *both* handles visible and Task 2 only having the one, this was not reflected in the results.

Together with the lack of difference in performance levels, the two task orders showed no significant differences in attention. However, in agreement with the previous studies, the children did pay more attention towards the first model presented to them. For the Number of Looks measure, this effect was particularly evident with the 2/1 task order. Task 2 therefore seems to have led to increased attention when presented first. This would be consistent with the view that this task was slightly more complex, which reflected the results of Study 1.

As expected the continuous exposure led to increased levels of attention. These children therefore attended to the model when they were given the opportunity to do so. Analysis of when the looking occurred showed that there were high levels of 'within' looking with the continuous exposure, therefore as hypothesised these children were continually checking their drawing with the model in front of them. For the Looking Time measure, this high 'within' looking was associated with the 2/1 task order. For the Number of Looks measure it was associated with the first task, and as stated earlier, high looking on the first task was associated with Task 2. Taken together this seems to suggest that Task 2 is possibly leading to high levels of 'within' looking, again reflecting the results of Study 1. This pattern was highlighted further when the attention of the intellectually and visually realistic drawers was compared. No significant main effects of drawing realism were shown, although there were only a few intellectually realistic drawers. However, what the analysis did reveal was that for Task 2 the visually realistic drawers were showing high levels of 'within' looking.

Unfortunately Task 1 did not show any relationship between drawing realism and look type. This would seem to suggest that this task was less complex, and therefore did not require this age group to continually check their drawing against the model in front of them. Task 2 contained both a partially occluded feature (back cup) and a totally occluded feature (the handle of the back cup), while Task 1 only contained the total occlusion of the body of the back cup. This may therefore provide a possible explanation for why the eight-year-olds found Task 1 simpler than Task 2. Although short exposure to Task 1 led to a significant reduction in performance, the extent of reduction was greater when presented with Task 2. Another possible explanation was the children's familiarity with the Task 1 model, in that it resembled a baby's cup.

The visually realistic drawers therefore showed an awareness of the necessity to keep attending to the drawing model in order to produce an accurate drawing. The intellectually realistic drawers at this age, although few in number, did not show such high levels of continued attention to the model. Removal of the opportunity to employ this strategy led to a reduction in performance. These results therefore clearly show that continued attention is essential for production of a visually realistic drawing of a complex model.

CHAPTER 6

DISCUSSION OF CROSS-SECTIONAL STUDIES

Chapters 2 to 5 provide detailed discussions of the specific results of Studies 1 to 4 respectively. However there were consistent themes that were evident across these studies, despite variations in procedures and drawing models. The present chapter will therefore discuss these themes and how they led to the longitudinal study that is presented in the following chapters of the thesis.

The age related changes in drawing performance were fairly consistent across the studies. Where the drawing model was more complex, for example in Study 1 and the Partial Occlusion task in Study 3, the significant increase in visually realistic drawings occurred between six and eight years of age. Where the task was more simple, for example the Handle Visible task in Study 2, the significant increase occurred between four and six years of age. For the Total and Non-Occlusion tasks in Study 3, there was a significant increase between each age group and therefore these tasks seem to present an intermediary level of complexity. Therefore, although the four-year-olds were generally intellectually realistic across tasks, and the eight-year-olds were generally visually realistic, the six-year-olds were showing how their drawing performance was affected by task difficulty.

The four-year-olds, although generally intellectually realistic, under certain circumstances produced some varying results. In Study 1 they were affected by the order of presentation of the cup models. If they were presented with a cup with its handle visible, prior to drawing a cup with its handle hidden from view, they were more likely to be visually realistic with the latter task. However due to the lack of control over the order of the tasks in this study, it was quite possible that these children had repeated prior exposure to a model with a visible handle. This order effect was not generally evident with Study 2 where the order of the cup tasks was controlled, or with Study 3 were the order of total and non-occlusion ball models were manipulated. Therefore it seems that a single exposure to the contrast between tasks was not sufficient to affect the performance of the four-year-olds. This age group had a tendency to produce two identical drawings, particularly in Study 2. They therefore seemed to be ignoring the models in front of them, especially the second one presented to them. These results were affected by the instructions and the order of presentation of the tasks. Therefore although these factors did not lead to increases in visual realism in the way that they did for the older children, they still systematically affected the children's performance.

The effects of instructions and presentation order on the six-year-olds did reflect previous literature, for the cup models at least. Explicit instructions and prior exposure to a cup model with its handle visible, both led to increases in visual realism on a cup model with its handle hidden from view (Study 2). These effects were however restricted to cup models and were not evident with occlusion ball models presented in Study 3. The eight-year-olds showed high levels of visual realism irrespective of the order of presentation and the instructions. However if they did not have the opportunity to attend to the model while they were actually drawing, and the model was complex enough, this age group showed a reduction in performance (Study 4).

The increases in visual realism with age were generally equivalent to the significant increases in attention that the children paid towards the drawing models. With the more simple tasks the age differences occurred between four and six years of age, and for the more complex tasks between six and eight years of age. The four-year-olds rarely looked at the model after the instructions had been given and once they started to draw. The older children however continued to attend while they drew, although this continuous attention did vary depending on the specific nature of the tasks and the instructions given. With the cup models presented in Study 2, the older children showed increased levels of looking 'within' drawing separate elements of the model, while the ball models presented in Study 3 led to increased looking 'between' drawing separate elements. This therefore reflected the differences between presenting a one or a two object model, and a more detailed or simple outline of the objects. Presenting the children with explicit instructions, which asked the children to "look very carefully", led to increased attention at all ages. While the younger children just tended to increase their 'beginning' looking, the older children increased their looking while they were actually drawing.

The older children therefore seemed to be using a more beneficial attentional strategy, and they were producing more visually realistic drawings. The explicit instructions seemed to prompt the six-year-olds to use the strategies spontaneously employed by the eight-year-olds, which subsequently seems to lead to the production of a visually realistic drawing. Direct comparison of this relationship between attention and drawing performance showed that, on the whole, the visually realistic children paid more attention to the drawing models than the intellectually realistic children. For Study 2 this related to increased attention 'within' drawing separate elements of the cup model, and for Study 3 increased attention 'between' drawing separate elements of the non-occlusion ball model. The visually realistic drawers were therefore continuing to attend to the models while they drew, with the type of attention varying with the specific nature of the drawing model.

The visually realistic drawers therefore appeared to be showing strategic attention. They were varying their attention to accommodate specific task demands in order to produce an accurate drawing of their view of the model. The eight-year-olds tended to use these attentional strategies spontaneously (most noticeable in Study 1), and therefore it is possible that they have extensive awareness of the necessity to attend to the models in order to produce an accurate drawing. The six-year-olds could be prompted to be more strategic by increasing the explicitness of the instructions. This age group also consistently showed high levels of spontaneous looking at the 'beginning' of the task. It is therefore possible that they have *some* awareness of the necessity to attend, but are as yet unsure of an appropriate way to do this. The fact that high levels of 'beginning' looking was not specifically associated with the visually realistic drawers at this age, would suggest that this strategy was not necessarily beneficial. Being told to "look very carefully" at the models seems to be a way of prompting the six-year-olds to adapt this limited awareness into an appropriate attentional strategy. It was also noticeable that when the four-year-olds were presented with explicit instructions they could be prompted into using the limited strategy adopted by the six-year-olds spontaneously i.e. they increased their looking at the 'beginning' of the task.

There seems therefore to be a developmental trend from being non-strategic, to the use of a limited strategy and finally to the use of extensive attentional strategies i.e. showing low levels of attention at the 'beginning' of the task, to showing high levels of 'beginning' looking and finally high levels of looking 'between' and 'within' drawing separate elements of the model i.e. continuously checking the model with their drawing. This increasing strategic ability is then reflected in more accurate drawing performance, with this pattern possibly being linked to an increasing awareness of the beneficial use of attentional strategies. Although the cross-sectional data presented in the previous chapters seem to provide evidence for this developmental pattern, in order to assess this more accurately it would be beneficial to demonstrate this development within a individual over time.

Attentional strategies and metacognitive awareness of these, have not been assessed in children's drawing research literature. However, they have been assessed in relation to other cognitive abilities. For example strategic memory and selective attention abilities have been shown to increase with age, along with increasing metacognitive awareness (Schneider & Sodian, 1988; Miller & Weiss, 1981). If there is a central underlying capability to be strategic, which is then applied to different cognitive behaviours, it would be expected that strategic attention and drawing performance would mirror the development of these other cognitive tasks that have been more widely documented in the literature. Therefore a short term longitudinal/cross-sectional study was conducted in order to assess the corresponding development of performance, strategic ability and metacognitive awareness in drawing, memory and selective attention. This study is presented in the remaining chapters of the thesis.

CHAPTER 7

LONGITUDINAL INTRODUCTION

7.1 DRAWING DEVELOPMENT

The cross-sectional studies reported in Chapters 2 to 5 show the relationship between the beneficial attentional strategy of continued attention to the drawing model, and the subsequent production of a visually realistic drawing. The four-year-olds generally do not use this strategy even when the instructions prompt them to do so. The six-year-olds are sensitive to these instructions, and although they do not do so spontaneously, they can be prompted into using this strategy. The eight-year-olds do spontaneously attend to the model and produce visually realistic drawings.

Although these results suggest age-related changes in strategic behaviour, it is problematic to assume this from cross-sectional data. It is possible that population differences between these groups were producing the observed effects. For example, the changes that have been made to the education system in recent years may have resulted in these age groups being taught quite differently. In order to give a clearer indication of the developmental changes in strategic behaviour, longitudinal data is necessary. However such studies are time consuming and therefore the alternative is a short-term longitudinal/cross-sectional study. This involves testing several age groups over a shorter period of time, which has the advantage of assessing developmental changes within the individual as well as across different age groups. This therefore provides data over a wide age range, without the necessity for extensive assessment over many years.

Studies 1, 2 (cup tasks) and 3 (ball tasks) generally showed significant increases in both attention towards the models, and visual realism between six and eight years of age for the more complex tasks or conditions, and between four and six years of age for the simpler tasks. Other studies report these age-related trends and how they can be affected by the task demands. Although it is widely documented that children under the age of eight are unable to draw partial occlusions, it has been demonstrated that by increasing the explicitness of the instructions, children aged six years and six months could successfully draw a partially occluded ball model (Cox, 1981; Barrett, Beaumont & Jennett, 1985). Similarly, children under the age of eight generally draw the hidden handle of a cup model. However, first asking the child to draw a cup with its handle visible at the side, leads to increased visual realism in five- and six-year-olds on a subsequent drawing of a cup with its handle hidden from view (Freeman & Janikoun, 1972; Davis & Bentley, 1984). This research therefore demonstrates age-related trends in the development of visually realistic drawings for a total occlusion cup model and a partial occlusion ball model. However longitudinal research is necessary before any firm conclusion can be drawn regarding the developmental sequence of drawing realism, and more importantly to assess how this reflects the developmental sequence in strategic attentional abilities.

From the research presented in Chapters 2 to 5, it seems that the four-year-olds have not yet made the link between attention and drawing performance, while the six-year-olds seem to be aware of the need to attend to the model but are unaware of the most effective strategy. They therefore tend to show increased levels of looking at the beginning of the task. The eight-year-olds however seem to have the metacognitive awareness of the relationship between these two behaviours and therefore continue to attend to the model while they are actually drawing. If you deny them the opportunity to do this their drawing performance deteriorates (Study 4).

Chen & Holman (1989) conducted a longitudinal study to compare children's realistic drawings between a total occlusion cup model and a partial occlusion ball model. They found that the ball task was more difficult, with a ceiling effect around nine years of age, as opposed to seven years of age for the cup task. However they provided a simultaneous contrast in that a non-occluded ball model was presented beside the partially occluded ball model, and a visible handle cup model was presented beside the hidden handle model. Davis (1983) had demonstrated that presenting such a contrast increased visual realism with the cup task. This may not be the case with the ball task and may therefore result in the discrepancy in performance between the two tasks. The two studies did however differ in another respect in that Chen & Holman asked the children to draw both models, while Davis only asked them to draw the cup with its handle hidden.

The cup task involves the *total occlusion* of the handle while the ball task involves the *partial occlusion* of the back ball. Cox (1991) stated that seeing part of an object may lead the child to believe they are meant to draw *all* of it, while a totally occluded object is often ignored. Therefore, due to the confounds of the children being presented with two contrasting models, and the instructions which stressed the 'behind' relationship [this has been shown *not* to affect a totally occluded ball task (Cox 1981, Study 2)] it is unclear whether the ball task is in fact more difficult or not.

Comparing the children's performance in Study 1 Task 1, which presented children with a single cup with its handle hidden from view, and Study 3 for the partial occlusion ball task with the standard instructions (equivalent to Study 1), it can seen that 40% of the four-year-olds, 50% of the six-year-olds and 100% of the eight-year-olds produced visually realistic drawings of the cup, compared to 0%, 1% and 67% respectively, for the ball task. This would again suggest that the ball task is more difficult to draw, however it is problematic to compare performance across two separate studies. Therefore assessment of children's drawing performance on these two tasks over time, without any contrast and with standard instructions, is necessary in order to provide a clearer indication of the developmental sequence in the production of visually realistic drawings, and how this relates to developments in strategic attention towards the drawing models, and children's metacognitive awareness of the relationship between these two factors.

7.2 MEMORY DEVELOPMENT

The influence of strategic behaviour on performance measures has been largely ignored in drawing research but has been demonstrated with other cognitive abilities such as memory and selective attention. Kail (1990), in a review of the literature, states that in general six-year-olds infrequently use mnemonic strategies, that there is a transitional phase between six and nine years, and that by ten years of age children are generally strategic on memory tasks. However it is noted that the younger children may not be as limited as the research would suggest. It is possible that they are able to use mnemonic strategies but do not necessarily do so spontaneously. If the tasks are designed to be relevant to young children's knowledge and experience, then performance is sometimes increased. This therefore reflects Cox (1981), who found that by making a partial occlusion drawing task more meaningful and related to concepts that a young child can understand such as hiding, children as young as four could successfully produce partial occlusion drawings.

There are many mnemonic strategies ranging in complexity, for example naming, visual examination, verbal rehearsal and visual or semantic categorisation. Baker-Ward, Ornstein & Holden (1984) reported how even four-year-olds made a deliberate attempt to use mnemonic strategies when instructed to remember a set of toys. However it was not until six years of age that these strategies led to increased recall performance. Moely, Olson, Halves & Flavell (1969) demonstrated how spontaneous semantic organisation of cards that the child was asked to remember, did not occur until ten years of age. However, through the use of instructions this ability could be provoked in five- to nine-year-olds, which subsequently led to increased recall performance.

Kobasigawa (1974) compared spontaneous and directed use of semantic cues by showing six-, eight- and eleven-year-olds 24 picture cards that could be grouped into eight categories. Cue cards were also presented, e.g. a picture of a zoo with empty cages related to the three animal cards etc.. When the relationship between the cue card and the picture cards was explicitly pointed out to the children, they were able to recall a higher number of cards, at all ages. Spontaneous use of the cues (relationship was not explicitly stated) increased significantly with age, as did recall ability in this condition. The six-year-olds were not spontaneously using the cues as a mnemonic aid, although they could be directed to do so. The eight-year-olds did spontaneously use the cues, but were limited in this ability in that they tended to use them to recall on average one of the three cards in the relevant category. It was not until eleven years of age that spontaneous exhaustive strategic behaviour was evident. This developmental sequence therefore seems to reflect the increase in attentional strategy use in drawing tasks. Younger children can be cued to pay more attention to the drawing models by presenting them with explicit instructions, although their strategy use may still be limited, i.e. they increase their looking at the beginning of the task. However it is the older children who spontaneously attend to the drawing model while they are actually drawing, which subsequently results in more visually realistic drawings.

Research has shown how awareness of these strategies can relate to their use. Sodian, Schneider & Perlmutter (1986) tested four- and six-year-olds ability to conceptually cluster an assortment of toys both at encoding and recall stages. They then assessed how these abilities related to free recall performance and the child's metacognitive awareness of this clustering strategy. With regard to their strategic development, the four-year-olds could be instructed to use a clustering strategy, but it was the six-year-olds who did so spontaneously. Although the six-year-olds' awareness of the strategy significantly related to recall performance, actual use of the strategy at either encoding or recall did not. The four-year-olds, however, showed no relationship between performance, strategy use and awareness. Schneider & Sodian (1988) showed how planful behaviour in memory tasks, e.g. using semantic cues similar to Kobasigawa task, was associated with some awareness of the usefulness of this strategy even at four years of age. Recall performance, the use of the strategy and metacognitive awareness all increased between four and six years of age. They therefore concluded that this awareness, although not sufficient, was necessary for the use of these mnemonic strategies.

Henry & Norman (in press) simplified the memory tasks and used a non-verbal meta-awareness questionnaire in order to adequately assess the relationship between recall and awareness in young children. They found that metamemory and the use or absence of simple naming strategies were related to two simple memory tasks, i.e. free recall of toys and picture memory span (remembering an increasing number of pictures). Flavell, Friedrichs, & Hoyt (1970) believed that naming may not be a deliberate strategy to aid recall but more of an automatic response. However Henry & Norman showed that irrespective of this, naming was an important early strategy that aided recall.

Cross-sectional research had therefore demonstrated age-related trends in memory performance, mnemonic strategy use and metacognitive awareness. However, in order to assess whether these patterns of results could be replicated within an individual over time, Schneider & Sodian (1991) conducted a longitudinal study. They found that conceptual organisation and recall did increase between four and six years of age, but found no corresponding increase in metacognitive awareness. Unfortunately the specific relationships between these different measures was not assessed and therefore there is no longitudinal evidence of how these abilities relate over time.

As well as providing the opportunity to draw more valid inferences from such data, longitudinal analysis also overcomes a problem pointed out by Cunningham & Weaver (1989). They argued that one of the possible explanations for younger children not performing well on memory tasks was their lack of experience of such tasks. They demonstrated a one-trial learning effect where the child's accuracy of predicting their memory span increased significantly between the first and second trials. Although this was different to the recall tasks in the above detailed studies, it suggests that multi-trial experiments are more valid, particularly when pre-school children are being assessed.

The research therefore demonstrates developmental increases in strategy use, recall performance and metacognitive awareness of the effectiveness of these strategies. Both strategy use and awareness are evident to some extent at four years of age, by six years children still seem to be limited in their behaviour and knowledge, and it is not until nine to ten years of age that children understand the effectiveness of these strategies and therefore spontaneously use them in an exhaustive manner.

7.3 SELECTIVE ATTENTION DEVELOPMENT

The developmental increase in exhaustive and efficient strategy use has also been demonstrated with regard to selective attention abilities. With age, children's attention becomes more selective in that it is less stimulus-driven and more directed by conceptual decision-making processes, and therefore more systematic and goal-oriented (Daehler & Bukatko, 1985). Vurpillot (1968) assessed children's scanning behaviour by presenting them with two houses each with six windows containing pictures. The children had to make judgements about whether the two houses were the same or different by comparing the pictures in the windows. Vurpillot videoed the children's eye movements and found that efficient scanning of the windows increased with age. By six to nine years of age the children were scanning the windows systematically by comparing homologous windows. If the two houses were the same then their search was exhaustive, however if they were different this age group tended to terminate their search as soon as they had found a difference. Such strategic search behaviour was not evident with pre-school children. The children's accuracy in differentiating the house pairs also increased with age. The nine-year-olds made practically no errors, however the younger children were better at judging similarity, with 90% of the four- and five-year-olds correctly assessing the similar houses and only 25% correctly assessing house pairs that contained one difference. Performance increased with the number of differences between the two houses.

However, Day & Bissell (1978) disagreed with Vurpillot's conclusion that four-year-olds are unsystematic in their visual scanning. Using the same task as Vurpillot they not only asked the children to judge the similarity of the two houses, but also asked them to justify their decision. They found that two-thirds of these children were systematic in their justifications, but that they were not basing their decision on the appropriate criteria. For example, some children made their judgements based on the similarity or dissimilarity of just one pair of windows, or on whether each row contained the same pictures even if the locations were different. They were therefore using a definite criterion for making their judgements and were not as unsystematic as Vurpillot concluded.

Another paradigm for assessing attentional strategies involves central-incidental learning tasks where children have to selectively attend to the central stimuli of the task in order to remember them, at the same time as ignoring the incidental stimuli which serve as possible distracters for the child's attention. The ability to selectively filter out the irrelevant information increases with age. Thus while recall of the central information increases, recall of the incidental information remains fairly constant until eleven or twelve years when it subsequently decreases (Hagen, 1967). It therefore seems that the older children are employing more appropriate attention allocation strategies.

Miller & Weiss (1981) question these conclusions because the strategies used can only be inferred from children's recall data with these tasks. They therefore attempted to assess these strategies directly, by making the children's search behaviour overt. Picture cards were positioned behind doors which the children then had to open in order to view the card. A drawing of a cage or a house was located on the front of each door in order to cue the child to the type of picture card behind it, i.e. either an animal or a household item respectively. The relationship between the drawing on the door and the picture behind it was pointed out to the children, and their understanding of this was checked. The authors then asked the children to remember the location of either the animals or the household objects. They were given 25 seconds to open as many doors as they wished before being asked to give the location of a particular picture card. The seven-year-olds generally opened all the doors in order, irrespective of the cue on the front of the door, while the ten- and thirteen-year-olds tended to only open the doors relevant to the type of picture card they had been instructed to remember. This study therefore directly observed the children's strategies of attention allocation.

Strategic behaviour was shown to increase with age, however Miller & Weiss wanted to assess whether this reflected decreases in children's recall of the incidental information. If a child was using the strategy of only attending to the relevant information would they then perform well on the usual central-incidental learning task? This involved showing the children cards which contained two pictures i.e. an animal and a household item. They were told to remember and then locate either the animals or the household items. Their memory for these items was then tested, followed by testing of which incidental item was paired with each central picture. Although memory for the central information increased between each age group, memory for the incidental information was fairly consistent between seven and ten years and then decreased between ten and thirteen years of age.

Miller & Weiss therefore demonstrated that the seven-year-olds showed a lack of strategic search behaviour, relatively poor recall for the central information and relatively high recall for the incidental information in comparison to the older children. The ten-year-olds showed good strategic ability, an increase in recall of the central items, but still showed comparable recall of the incidental items to the seven-year-olds. The thirteen-year-olds showed good strategic ability, significantly higher recall of the central items and poor recall for the incidental information. This age group was therefore using an effective strategy of attention allocation. Although the ten-year-olds were strategic in their search behaviour they were still able to recall the incidental information in the second task. It seems therefore that they have the ability to use the appropriate strategy but do not seem to have the awareness of how to do so effectively in all circumstances. However, there was in fact little evidence of metacognitive awareness of the appropriate strategy of only attending to the relevant information in the second task, with only 16%, 25% and 40% of seven-, ten- and thirteen-year-olds respectively, being able to state that they had used this strategy. However it is possible that the strategy use was unconscious, or that the child was unable to verbalise the basis of their behaviour.

DeMarie-Deblow & Miller (1988) investigated the lag between using a selective attention strategy and benefiting from it. Using Miller & Weiss' door opening paradigm, the children either opened the doors themselves (spontaneous strategy use), or the experimenter opened the doors for them by approximating the different types of opening strategies used by the children spontaneously. Spontaneous strategy use increased between seven and eight years. However by removing the effort involved in employing the strategy these age differences disappeared. They therefore concluded that the lag between producing and benefiting from a selective attention strategy was produced by the effort necessary in actually using the strategy.

7.4 CONCLUSIONS

Therefore, previous research of memory and selective attention suggests that strategic behaviour increases with age, although the critical age differs between abilities and tasks. It seems that strategy use develops initially without immediate benefits on performance. This is possibly due to the child not using the strategy as effectively as possible or due to the effort involved. Generally at this stage a child does not seem to have any metacognitive awareness of their strategic behaviour. As a child gets older and more experienced, more efficient strategy use begins to be reflected in increased performance, and increased awareness of their behaviour. The developmental pattern in strategy use therefore reflects the conclusions drawn in previous chapters. Strategic attention begins to develop around six years of age but is ineffective until eight years of age when the children continually check their drawing with the model in front of them. However, whether the children have any metacognitive awareness of this strategy use is as yet unknown.

Although the development of realism in children's drawings has been widely assessed, the relationship between this and both strategic attention and metacognitive awareness have not. However, there are striking similarities in the patterns of development established in this thesis and the literature on memory and selective attention. Therefore it would be advantageous to demonstrate comparable development in these three areas of cognition within an individual, in order to confirm the theory of how strategic attention relates to drawing performance. This would also provide the opportunity to place drawing in a broader cognitive context whereas in the past it has generally been assessed in isolation (with the exception of Piagetian Theory). If strategy use can be shown to be similar in different cognitive tasks this would suggest that children develop a central strategic understanding which is then applied to different cognitive tasks.

7.5 AIM OF LONGITUDINAL STUDY

The present study therefore aimed to assess the relationships across the development of performance, strategic behaviour and metacognitive awareness of these strategies, for drawing, memory and selective attention tasks. Children initially aged four, five and six years of age were assessed three times over a one year period. The drawing task consisted of a partial occlusion ball model and a cup with its handle totally occluded. In order to eliminate some of the methodological confounds in Chen & Holman's (1989) longitudinal study, the children were not presented with any contrasting model and only heard standard instructions. The children were then questioned on their knowledge of the effective strategy of continued attention to the drawing model. For the memory task, picture cards were presented in a random arrangement and grouped together into several categories, and recall assessed. Metacognitive awareness of the mnemonic strategy of conceptual categorisation was then assessed using a procedure adapted from Schneider & Sodian (1991). For the selective attention task, the children were asked to make judgements about the similarity/dissimilarity of pairs of houses similar to Vurpillot's (1968). However in order to make allocation of attention overt, the children were required to open 'shutters' covering the windows, in order to view the pictures underneath. This was therefore an adaptation of Miller & Weiss' (1989) procedure of placing the picture cards behind doors. In agreement with Day & Bissell's (1978) procedure, the children were asked to justify their decisions regarding why the house pairs were the same or different.

The hypotheses for the drawing data were that:-

1: Visual realism, strategic attention and metacognitive awareness would all increase with age.

2: The ball task would be more difficult than the cup task.

The hypotheses for the memory data were that:-

1: Recall performance, clustering of items, and metacognitive awareness would all increase with age.

2: Recall performance would be improved by the categorised arrangement of the cards.

The hypotheses for the selective attention data were that:-

1: Correct judgement of the similarity/dissimilarity of pairs of houses, strategic opening of the windows, and metacognitive awareness of their judgements would all increase with age.

2: Correct judgements would increase with the two identical houses, or where there were several differences. Correct judgements would decrease with only one difference or where the pictures were placed in different spatial locations.

The hypothesis for the cross-sectional data was that the developmental sequence in performance, strategy use and metacognitive awareness would be similar across tasks. This would allow drawing performance to be placed in a broader cognitive context.

The hypothesis for the longitudinal data was that the development of strategic behaviour would be related to increased performance and metacognitive awareness within the individual over time.

CHAPTER 8

LONGITUDINAL STUDY PHASE 1

8.1 METHOD

8.1.1 SUBJECTS

Sixty children were randomly selected by the experimenter from the relevant classes in one Plymouth school. There were twenty children in each age group with mean ages of 4 years 1 month (range 3:9 to 4:4, standard deviation 0:2 months), 5 years 1 month (range 4:10 to 5:4, standard deviation 0:2 months) and 6 years 11 months (range 6:7 to 7:2, standard deviation 0:2 months). There were thirty-two males and twenty-eight females in total. There were ten males and ten females in the four-year-old age group, and nine males and eleven females in each of the five- and six-year-old age groups.

The older age group were in fact ten months older than would have been liked. The experimenter requested children that were aged 4, 5 and 6, and although the school provided children from these year groups, due to the first phase of testing taking part mid way through the school year, the six year olds were unfortunately nearing their seventh birthdays.

8.1.2 DESIGN

A 3 (age) x 3 (task) x 3 (assessment phase) short term longitudinal/cross-sectional design was conducted, with independent groups for the first factor and repeated measures for the second two. The independent variable for the drawing task was the drawing model (balls vs. cup), for the memory task the arrangement of the picture cards (grouped vs. mixed), and for the selective attention task the similarity of the house pairs (same vs. different). The dependent variables for the drawing task were classification of drawings as visually or intellectually realistic, the amount of attention paid towards the drawing model and the responses to the meta-awareness questions. The dependent variables for the memory task were the number of correctly recalled picture cards, the amount of categorical clustering at recall and the responses to the meta-memory questions. The dependent variables for the selective attention task were the number of accurate judgements of whether the houses were the same or different, the strategies used to open the windows, and the responses to the meta-awareness questions.

8.1.3 MATERIALS

Drawing Task

One plain white coffee mug, with a handle, measuring 9.5 cms. high and 8 cms. wide, and two identical featureless pink balls measuring 10 cms. in diameter, were used for the drawing models. These were placed on an inverted box measuring 26 cms. high, in order to ensure presentation at eye-level. Plain A5 white paper and a black pencil were given to the children to draw with.

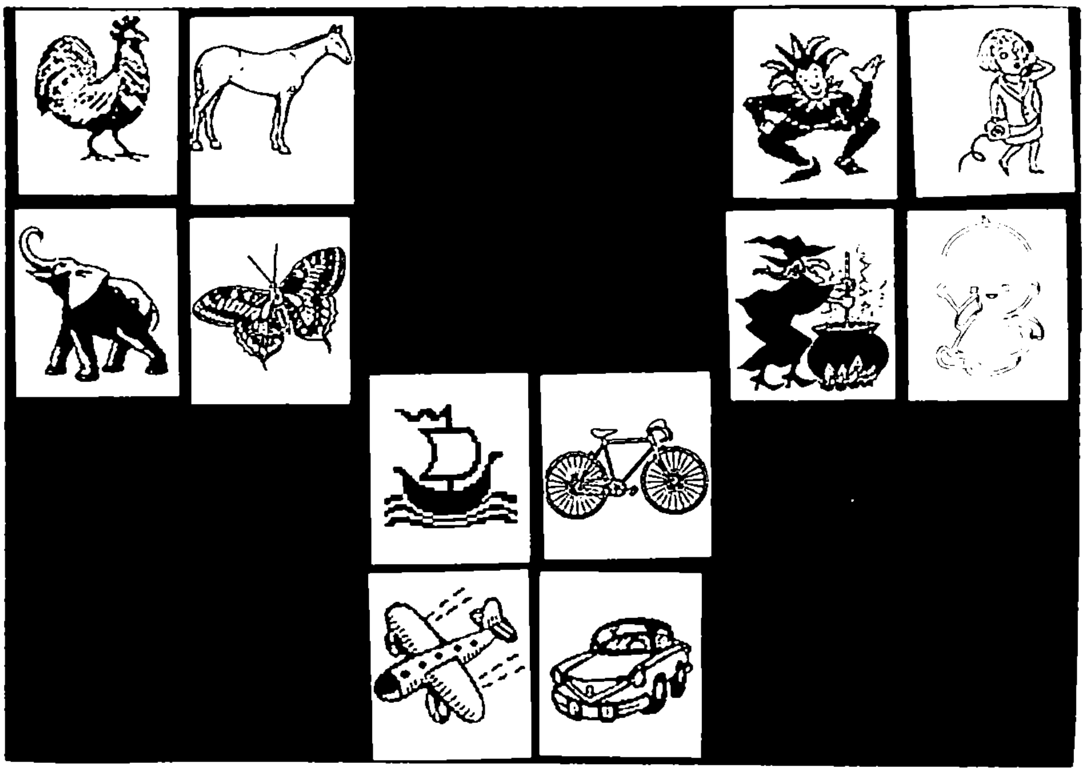
Memory Task

Two sets of 12 different black and white picture cards were made using computer "clip art" mounted onto cartridge paper measuring 7 cms. square. One set of cards consisted of four methods of transport, four animals and four people ('T' set). The other set ('H' set) consisted of four household items, four food items and four animals (different to those in the first set). There were therefore three categories with four cards in each. These two sets of cards are illustrated in Figure 8.1. This was consistent with Murphy & Puff's (1982) recommendations of between three and twelve categories with three to five items in each.

Another set of 12 cards were arranged either grouped into their categories and also positioned randomly. Each arrangement was then photocopied onto plain A4 paper. This set consisted of four pieces of fruit, four food items (different to those used in the above set) and four animals (different to the above). See Figure 8.2 for an illustration of this task.

FIGURE 8.1 MATERIALS FOR THE MEMORY TASK

THE 'T' SET OF CARDS IN THE GROUPED DISPLAY TYPE



THE 'H' SET OF CARDS IN THE MIXED DISPLAY TYPE

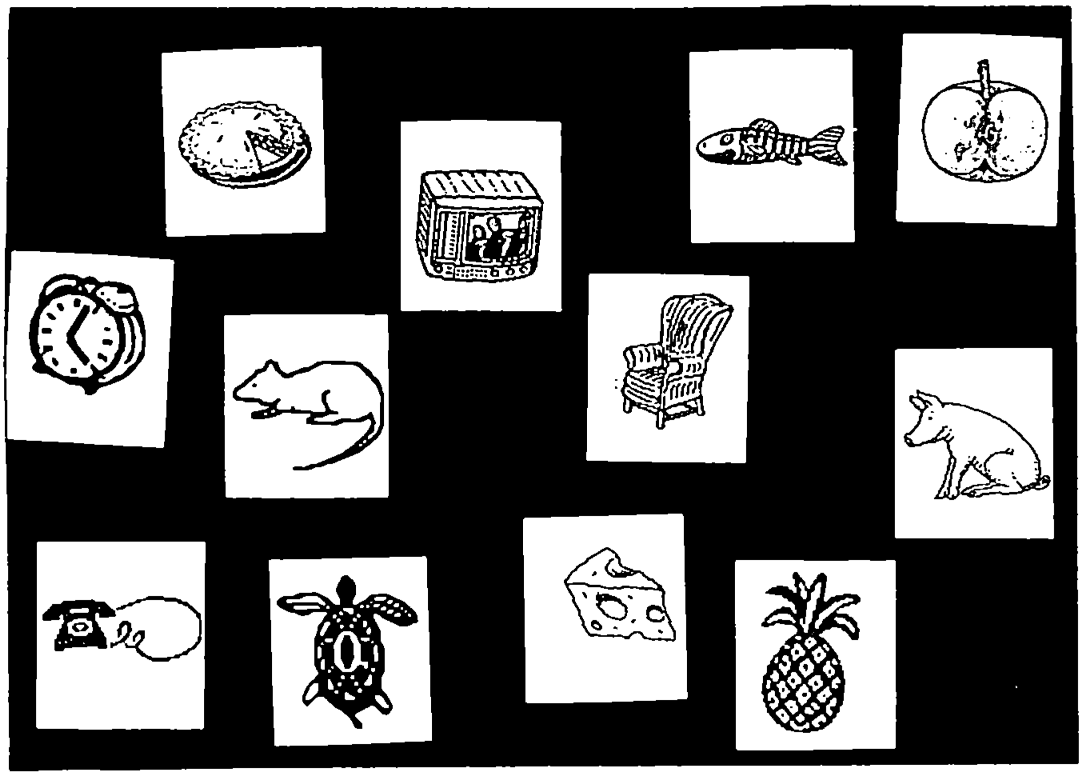
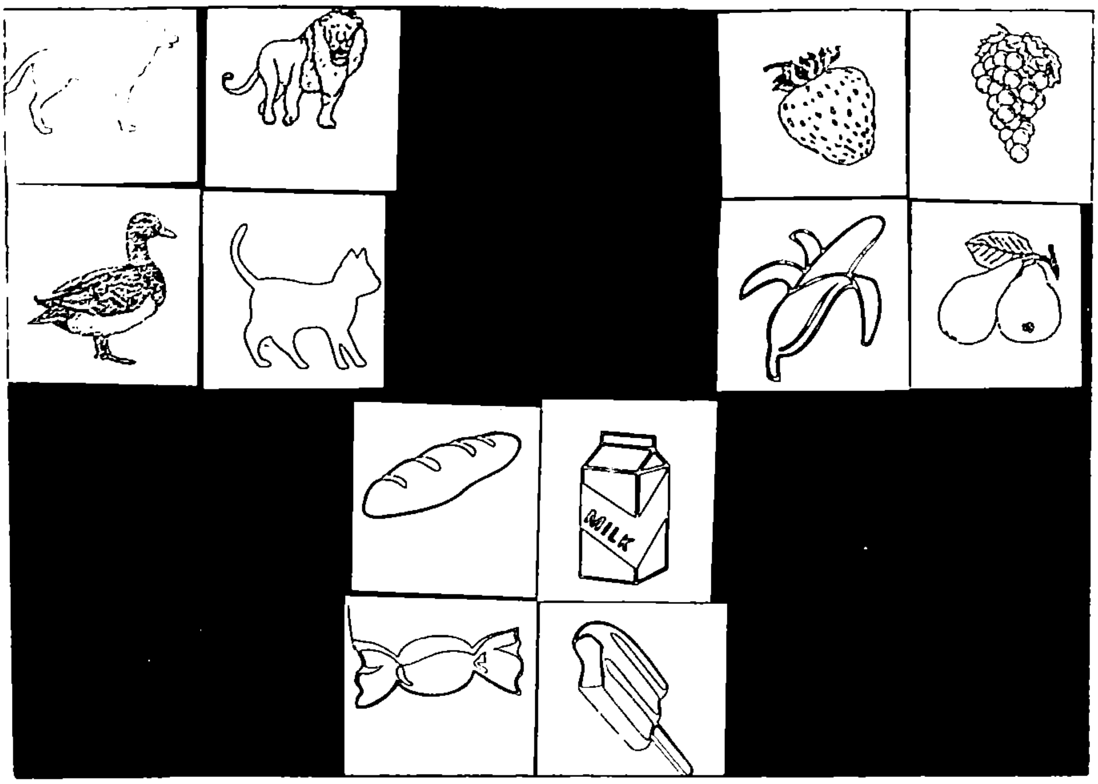
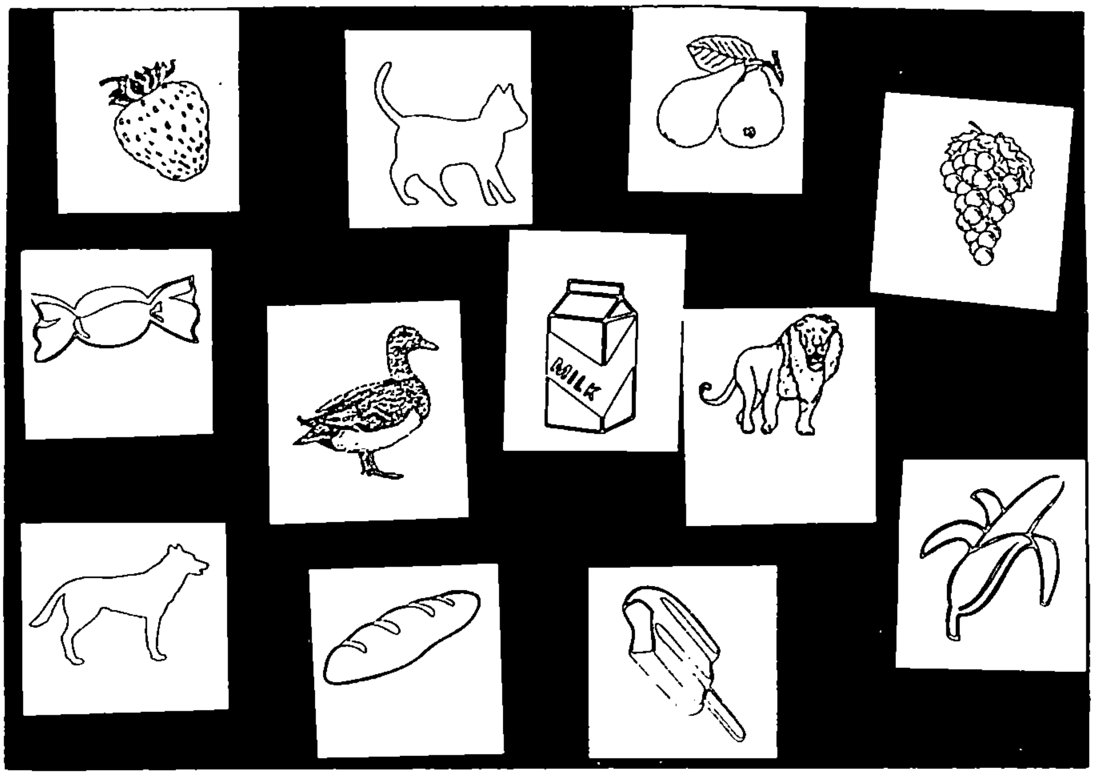


FIGURE 8.2 MATERIALS FOR THE META-MEMORY TASK





Selective Attention Task

A house, consisting of a roof, a chimney, a door and three rows of two windows, was drawn with a black pen onto A4 white paper. The house measured 21.5 cms. wide and 30 cms. high and each window measured 6.5 cms. wide and 6 cms. high. The windows were then cut across the top and bottom, and down the centre to produce 'shutters'. This is illustrated in Figure 8.3. Six different black and white pictures (computer "clip art") were mounted onto another piece of A4 white paper in the same position as the windows of the house. The house was then mounted on top of this, keeping the 'shutters' free so that they could be opened in order to reveal the pictures underneath. The house was then mounted onto cartridge paper.

Six pairs of houses were constructed so that one pair had identical pictures in all homologous windows (Pair 1); one pair had a difference in one pair of homologous windows (Pair 2); one pair had a difference in two pairs of homologous windows (Pair 3) and one pair had the same pictures in each house but the position of four of them were reversed (Pair 4). The final two were practice pairs, one with identical pairs of homologous windows (Ps) and the other pair with a difference in two pairs of homologous windows (Pd). See Figure 8.4 for full details of these six house pairs.

8.1.4 PROCEDURE

8.1.4.1 Pilot Study

Ten children were randomly selected from a University Play School with a mean age of 4 years 2 months (range 3:5 to 4:9, standard deviation 0:5 months). There were four males and six females.

This Pilot study was conducted in order to assess the difficulty of the memory and selective attention tasks for the nursery aged children, and also to assess any initial problems with the materials.

For the memory task the children were shown the 'T' set of cards detailed above. These were presented in a random and a grouped arrangement (the order of which was

FIGURE 8.3 ILLUSTRATION OF THE WINDOW OPENING FOR THE SELECTIVE ATTENTION TASK

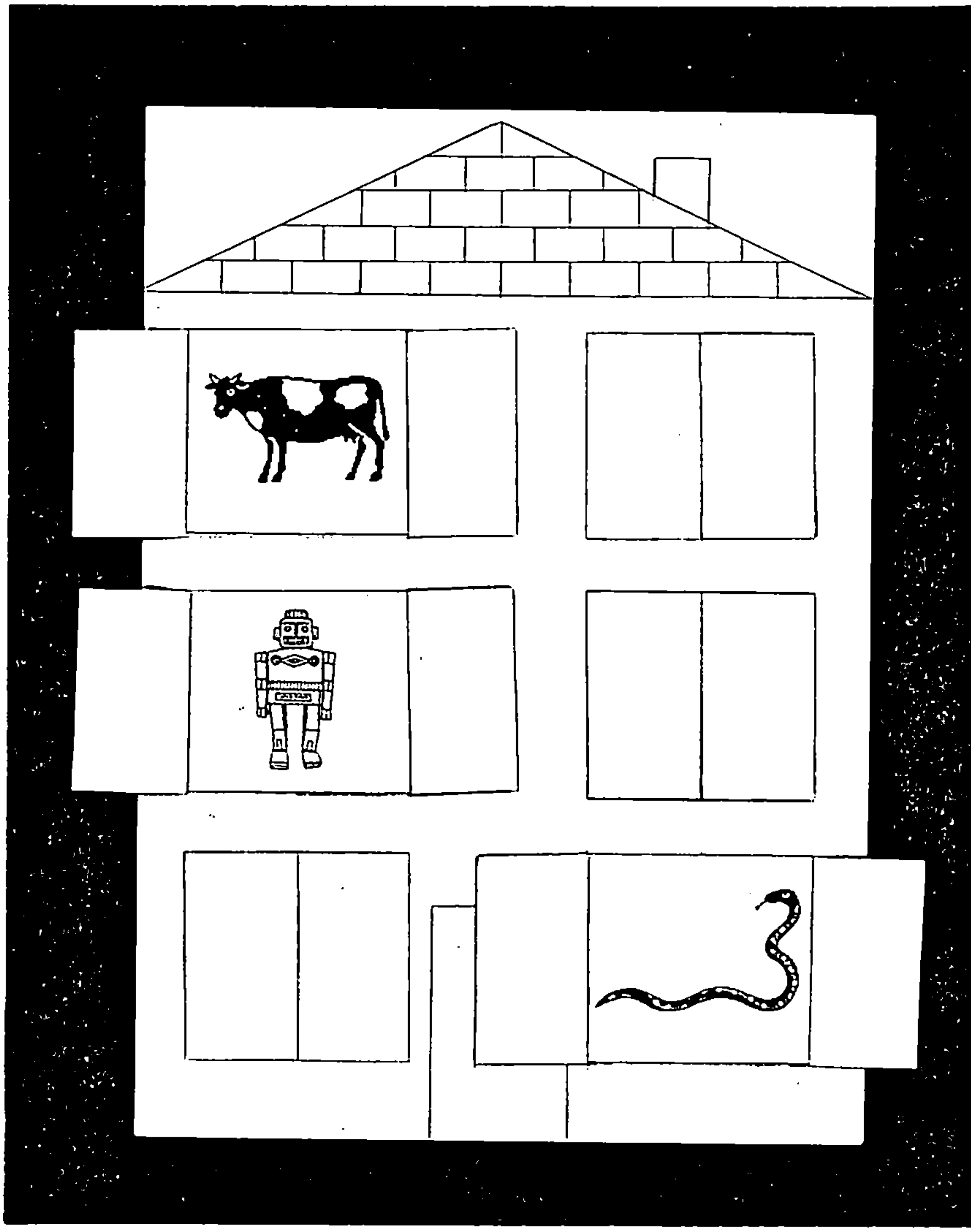
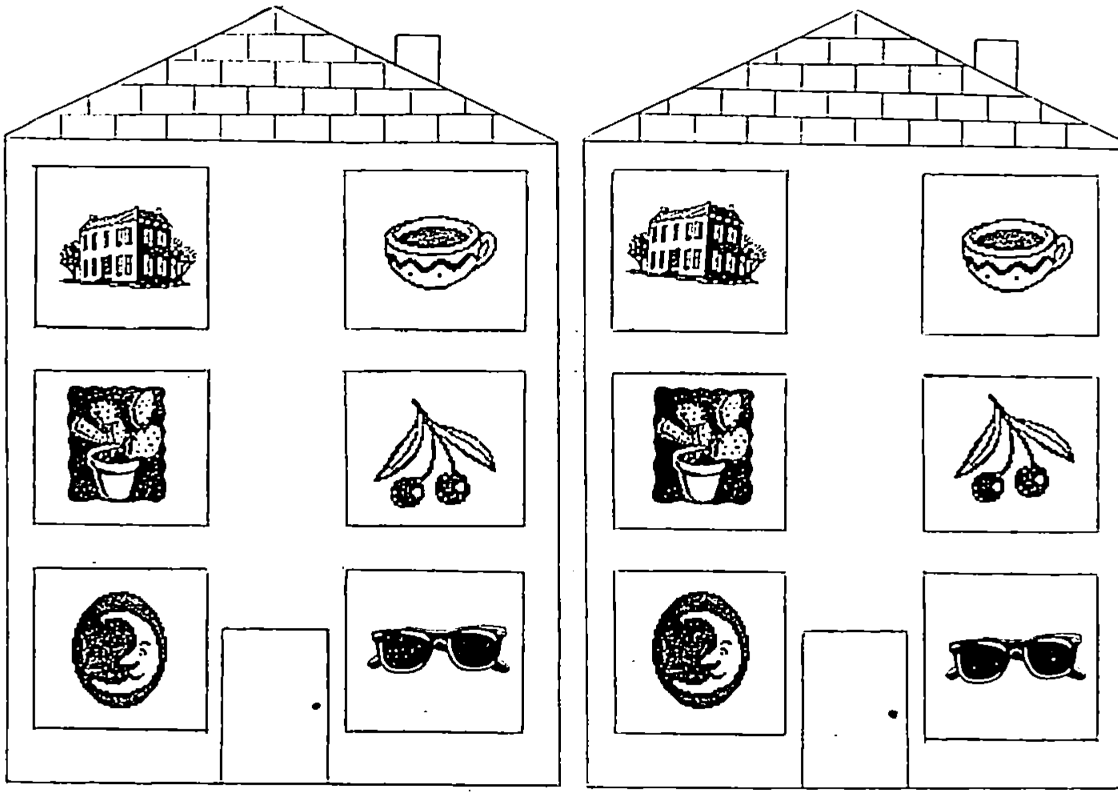


FIGURE 8.4 **ILLUSTRATION OF THE SIX HOUSE PAIRS FOR THE SELECTIVE ATTENTION TASK**

PAIR 1



PAIR 2

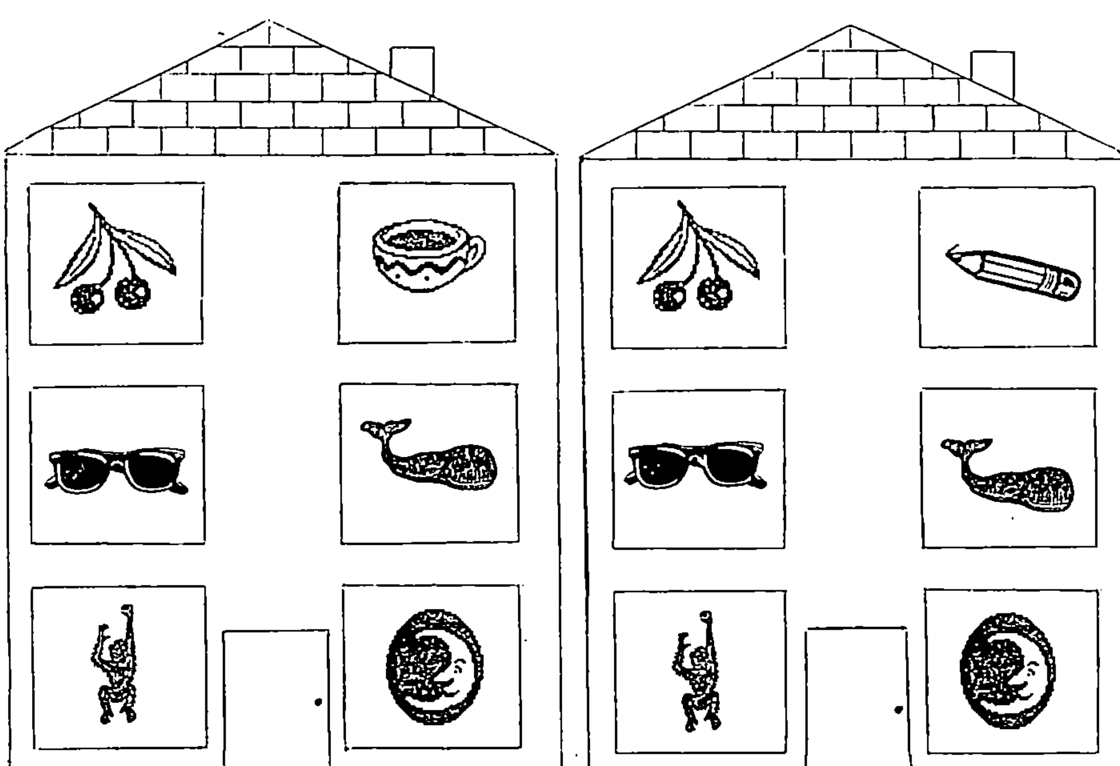
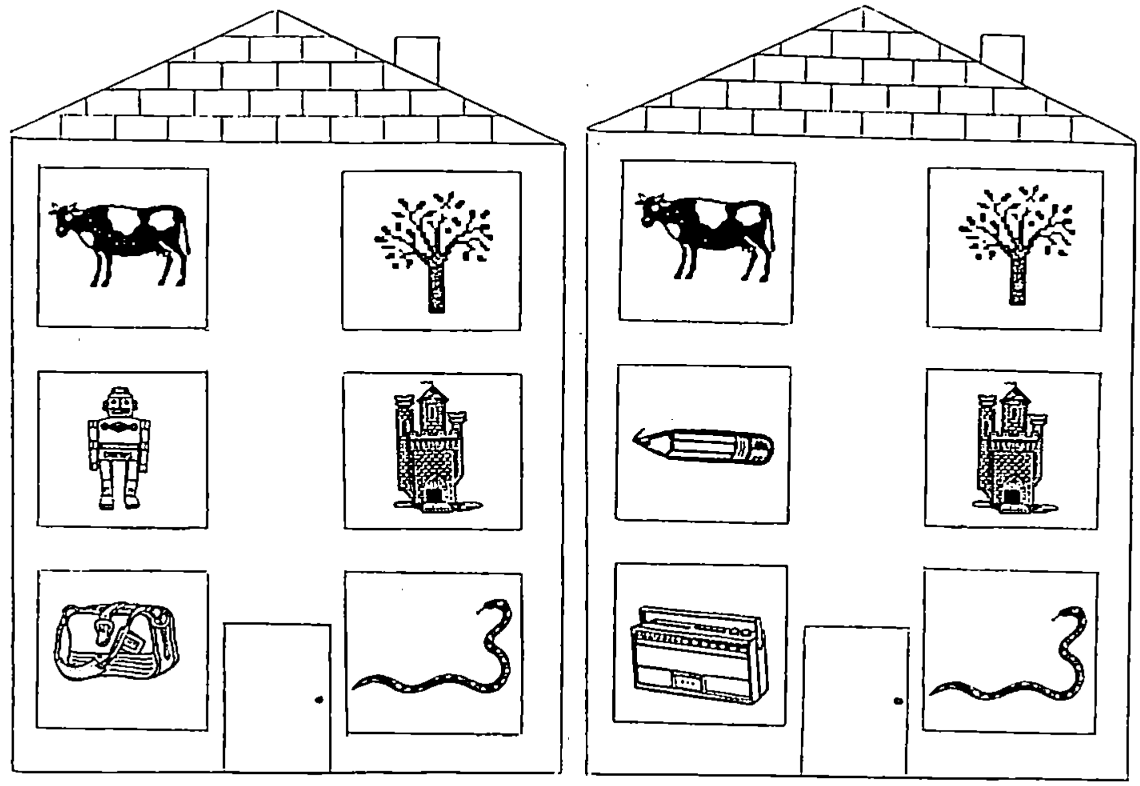


FIGURE 8.4 (continued)

PAIR 3



PAIR 4

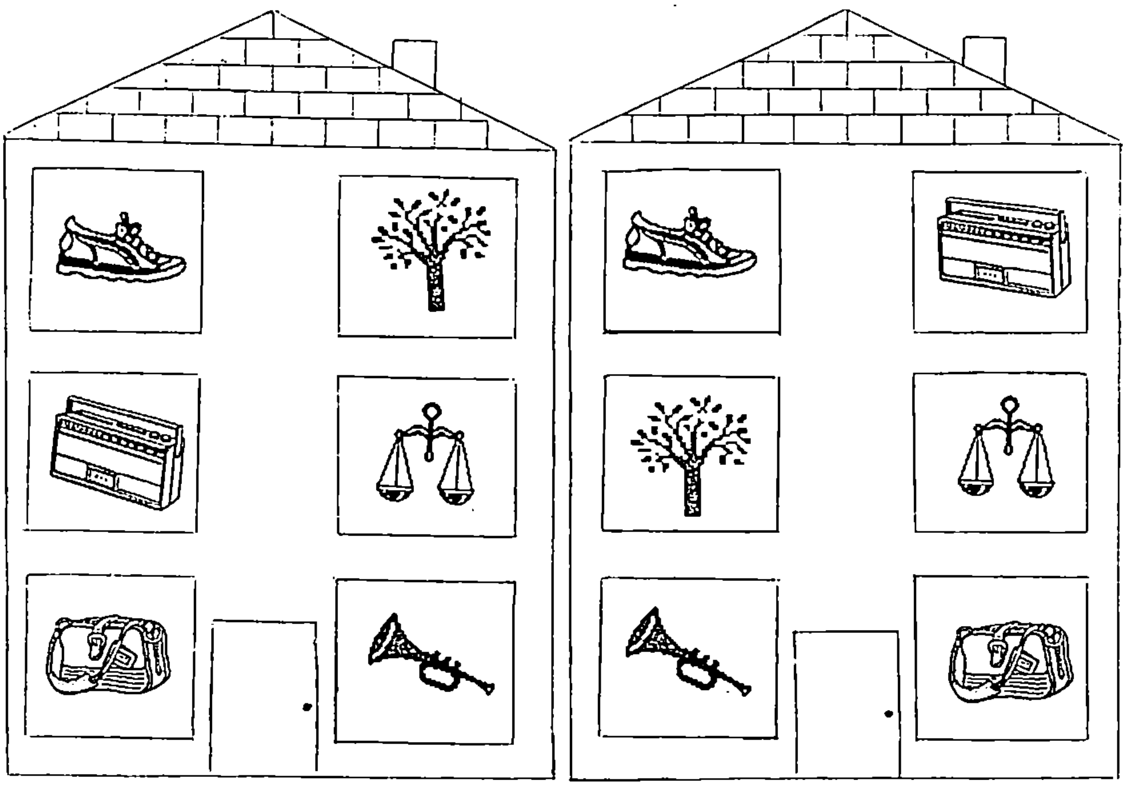
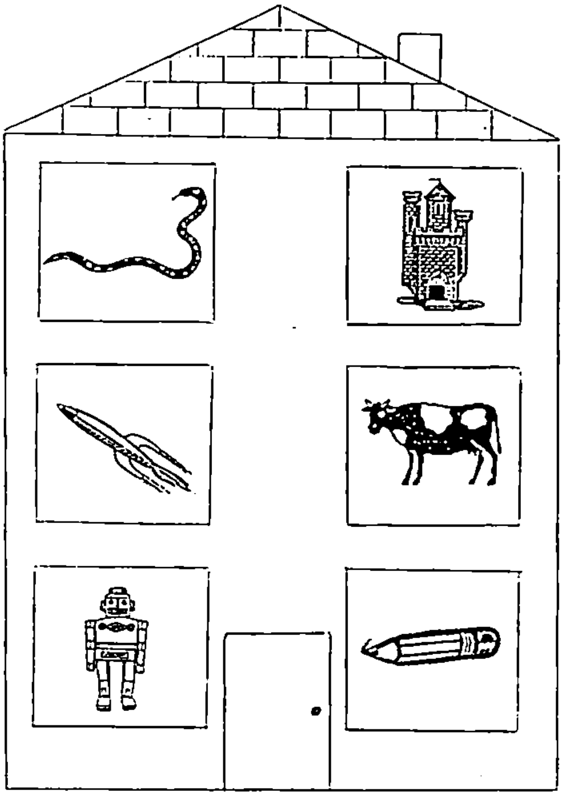
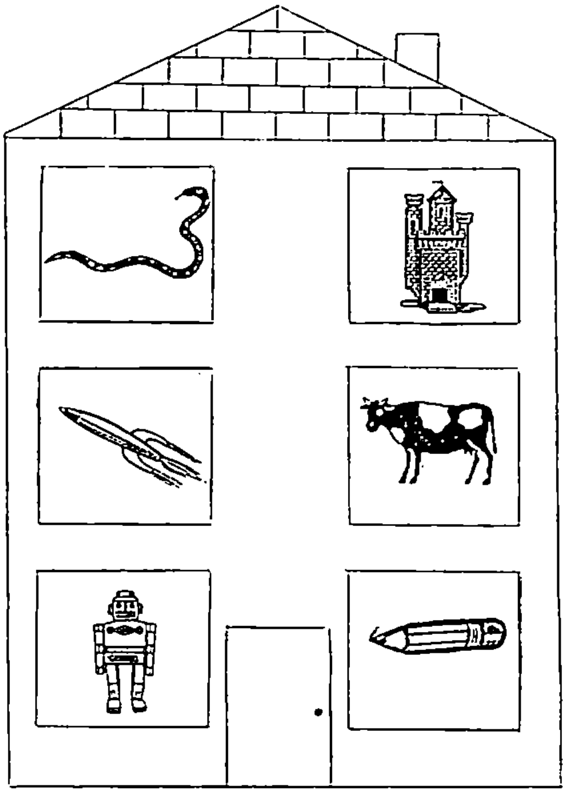


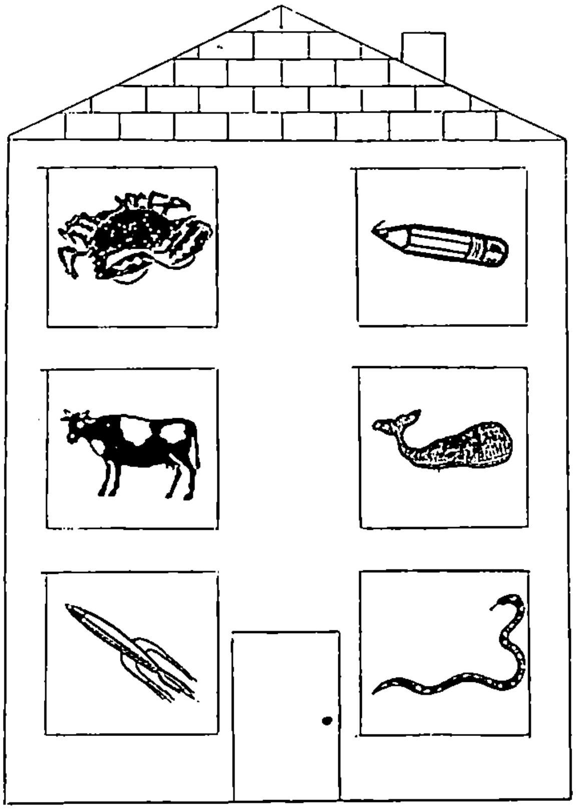
FIGURE 8.4 (continued)

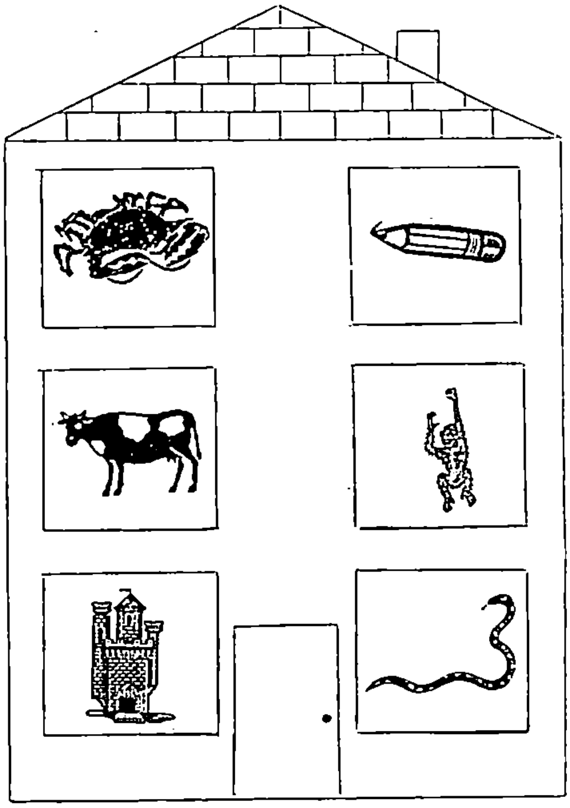
PRACTICE PAIR (SAME)





PRACTICE PAIR (DIFFERENT)





counterbalanced) for rehearsal and recall. Full details of the procedure are given in the main procedural section. The children recalled on average 4 out of the possible 12 items. These young children did not show any indication of not understanding the instructions. However the 'H' set of 12 cards was constructed in order to control for carryover effects, and it was decided that the transport items in the 'T' set should be referred to as "things we ride in or on" as some of the children did not understand the term 'transport'. This therefore ensured that the language used was appropriate for this age group.

Each child was given one minute to study the cards, however nearly all the children stopped after naming the cards once. They then had to be prompted to keep naming them, however some of the children were reluctant to do this stating that they "already knew them". Therefore it was decided that naming once would be sufficient especially as those children who insisted on using this strategy were still capable of recalling several of the cards. In this way each child's experience would be the same. However a maximum limit of one minute was imposed in the experimental study.

The meta-memory task proved very difficult. The children were shown three pieces of A4 paper on which were photocopied the 'T' set of cards. On one piece of paper the cards were arranged randomly, on another they were arranged so that the cards of the same category were grouped together, and on the third they were arranged in three groups of four, but the pictures in each group were not all from the same category. This procedure was taken from Schneider & Sodian (1991).

The children were asked which arrangement they thought would help them to remember the pictures more. Most of the children were unable to understand what they were being asked to do, and even if they were able to choose an arrangement, they were unable to justify why they had come to this conclusion. Although this was to be expected, it was decided that in order to simplify the procedure, only the random and grouped by category arrangements would be used in the experimental study. A third different set of cards was constructed for the meta-memory questions in order to reduce confusion with the memory recall task.

For the selective attention task only the two practice pairs were used. Full details of the procedure are given in the main procedural section. This showed that the children were capable of understanding the task. However originally the 'shutters' over the windows were of different colours in order to make the task look more 'attractive' to the children. When asked to give a reason why the houses were the same or different, four out of the ten children stated the colour of the windows as the reason. The houses used in the experimental study were therefore plain white.

8.1.4.2 Experimental Study

Each child was tested individually by the same female experimenter in a private room at the school. A video camera was angled to observe the child's direction of gaze and the table in front of them. The experimenter tried not to draw too much attention towards the camera's presence in the room, by keeping contact with it to a minimum. After establishing rapport, each child performed the three tasks, the order of which was counterbalanced.

Drawing Task

The child was asked to sit squarely at a table where the inverted box had been placed directly in front of them, with the centre of the box at a distance of 100 cms. from the child. The child was given a plain piece of white paper and a pencil. The experimenter stated "I am going to ask you to do two drawings for me. Each time I want you to draw exactly what you can see from where you are sitting". The model was then placed in the centre of the box. The cup was placed so that the handle was turned away and therefore hidden from sight. The experimenter said "Here is a cup. Please draw exactly what you can see from where you are sitting".

The balls were placed so that one ball was behind and to the right of the other. The front ball therefore partially occluded the back ball. The experimenter said "Here are two balls. Please draw exactly what you can see from where you are sitting". The order of these tasks was counterbalanced. If the child was unsure of what (s)he was required to do the instructions were repeated. The children were given as long as they required to complete each drawing.

After the child had drawn each model the experimenter praised the drawing then said "While you did that drawing I left the cup/balls in front of you. If instead I had just shown you the cup/balls and then hidden it/them (the cup/balls were then removed and hidden under the table) before you started to draw, do you think you would still have been able to produce such a good drawing". The child was then asked why they thought they could/could not still draw the model even if it was not in front of them. The child's responses were then noted.

Memory Task

The order in which the two sets of cards were presented and the two display types of the cards were counterbalanced, resulting in four possible combinations ('T' set grouped followed by the 'H' set random; 'H' grouped 'T' random; 'T' random 'H' grouped; 'H' random 'T' grouped). With the first set of cards the child was told "Here are some cards with pictures on. Let's name them together while I lay them on the table". The cards were then laid out either in a random arrangement, or in three groups so that the four cards in each category were placed together (see Figure 8.1). The child and the experimenter named the pictures as they were laid out. The experimenter said "I want you to look at these cards for a little while, then I will take them away and I want you to tell me all the pictures you can remember seeing". If the cards were in the random arrangement the experimenter then said "Maybe it would help you to remember them if you name and point to the cards while you look at them". If the cards were in the grouped arrangement the experimenter said "I have put together all the cards that go together. Here we have all the animals, here we have all the people/food and here were have all the things you find in a house/things we ride in or on. Maybe it would help you to remember them if you name and point to the cards in their groups, while you look at them".

Each child was then given time (no longer than one minute) to name and point to the cards. If the child missed any of the cards, the experimenter pointed to them and asked the child

"What is this?". The experimenter also helped the child if they were unable to name any of the cards. When the child had finished naming them all, the cards were removed and the experimenter asked the child to "Tell me all the pictures you can remember seeing". Their responses were recorded. The child was then shown the other set of 12 cards in the other arrangement and the same procedure was repeated.

For the meta-memory task, which was adapted from Schneider & Sodian (1991), the child was shown the photocopies of the two different arrangements. The experimenter said "If I was going to ask you to remember another set of cards, I am not going to but if I did, I could lay them out on the table either all mixed up like this (pointing to the random arrangement) or, I could put together all those pictures that go together like this (pointing to the grouped arrangement), here are all the animals, all the food and all the fruit. If you had a choice which would you choose? Which would help you to remember the pictures more, either all mixed up or grouped together?". The order of the mixed and grouped arrangements was counterbalanced. If the child did not understand the question, the instructions were repeated. The child was then asked "Why do you think this would help you to remember?". Their responses were noted by the experimenter.

Selective Attention Task

The order of the two practice pairs was counterbalanced. Order effects for the four experimental pairs were controlled by a Latin Square. There were therefore four possible orders (Pairs 1234, 2341, 3412, 4123).

The experimenter said "I am going to show you several pairs of houses". The first practice pair was placed in front of the child. The child was told that "Here are two houses. Each house has six windows which can be opened to show pictures underneath". A window was opened in order to demonstrate this to the child. The experimenter said "The idea of the game is to decide whether this house (pointing to one house) is the same or not the same as this house (pointing to the other), by opening the windows and looking at the pictures underneath. First of all we will have a practice so I am going to tell you that these two houses are the same/not the same. Why don't you look at the pictures in the window so you can see why they are the same/not the same. You can open as many windows as you like". The child was then allowed to open the windows, the order of which was noted by the experimenter. The child was then asked "Can you see why the two houses are the same/not the same". If the child could not see this, the experimenter repeated "Can you see why this house (pointing to one) is the same/not the same as this house" (pointing to the other). The criteria for making the judgement regarding whether the houses were the same or not, was therefore not specified by the experimenter. The procedure was then repeated for the other practice pair.

After completion the experimenter said "Now we have had a practice, we are going to play the game. This time I want *you* to tell *me* if the two houses are the same or not the same by looking at the pictures in the windows. You can open as many windows as you like". The order in which the windows were opened was noted. When the child indicated that they had finished opening the windows they were asked whether the houses were the same or not the same. The experimenter then said "Please can you tell me or show me why they are the same/not the same", and their responses were recorded. The child was then shown the next pair and the procedure was repeated. This procedure was adapted from Day & Bissell (1978).

8.1.5 SCORING

Drawing Task

The cup drawings were classified into three categories.

1: A visually realistic drawing omitted the hidden handle.

2: An intellectually realistic drawing included the handle.

3: A scribbled drawing contained no recognisable features.

The ball drawings were classified into four categories.

1: A visually realistic drawing showed one ball partially occluding the other by the successful use of hidden-line elimination.

2: An intellectually realistic drawing showed two complete circles either separate from, touching each other, or overlapping (transparency).

3: An omission drawing contained only a single ball.

4: A scribbled drawing contained no recognisable features.

Examples of the intellectually and visually realistic drawings are shown in Table 8.1.

Each child's attention towards the model in front of them was scored in two ways. Firstly the number of looks and secondly the time spent looking at the model. These two measures were divided into the number of looks or looking time at the 'beginning' of the task before drawing commenced; 'between' drawing separate elements of the model; 'within' drawing a particular element and at the 'end' of the task after the drawing had been completed.

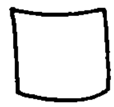
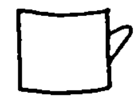
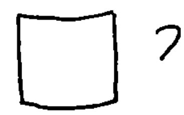
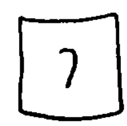
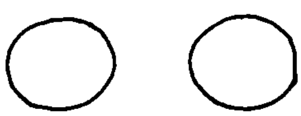
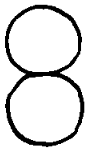
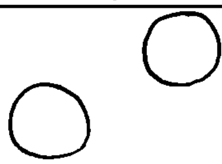
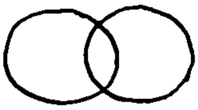
The subjects were further divided into three categories on the basis of the extent of strategic attention the child paid towards the model. This was carried out in order to provide a comparable classification across the three tasks, so that strategic abilities in drawing, memory and selective attention could be compared. If a child looked either 'between' or 'within' they were classified as Extensively Strategic. If the child showed higher than average looking (for their age group) at the 'beginning' of the task and no 'between' or 'within' looking, they were classified as Limited Strategic. Finally, if a child showed below average looking at the 'beginning' of the task and no 'between' or 'within' looking, they were classified as Non-Strategic. These classifications were based on the results of Studies 1 to 4, which suggested that the six-year-olds were attempting to change their attentional behaviour, by increasing their 'beginning' looking, however this change in strategy did not necessarily lead to an improvement in drawing performance. This strategy was therefore not as effective as looking 'within' and 'between'.

The meta-awareness questions with regard to why the child thought they could/could not draw the model even if it was not in front of them were classified into three categories.

1: Extensive Awareness - Reference to seeing and attention.

2: Limited Awareness - Reference to knowledge about cups/balls in general or the specific cup/ball model; confidence in own abilities to draw and descriptions of the models.

TABLE 8.1 CLASSIFICATION OF DRAWINGS

DRAWING MODEL	VISUAL REALISM	INTELLECTUAL REALISM
CUP		
		
		
BALL		
		
		
		
		
		

3: No Awareness - Reference to copying their previous drawing; naming the model; "dont know" responses or any irrelevant justifications.

For full details of the type of responses for each category see Appendix J.

Memory Task

The number of correctly recalled pictures for each set and arrangement of cards was calculated. This score excluded any repetitions, intrusions from the other set of cards and items that were not included in the set of cards.

In order to establish the amount of category clustering in each child's recall performance, the Adjusted Ratio of Clustering (ARC) score was calculated, as used by Kee & Bell (1981). The ARC represents the proportion of actual category repetitions (how often an item from a category was preceded by an item from the same category) above chance, to the total possible repetitions above chance, for any particular recall protocol. This measure has been shown to be independent of the total number of items recalled and the number of categories recalled (Roenker, Thompson & Brown, 1971). The scores range from 1.00 representing perfect clustering, and -1.00 representing no clustering, with the overall chance level of clustering set at zero. Any repetitions of a particular card in the recall protocol were included as placeholders in the number of category repetitions (Kee & Bell, 1981).

Schneider & Sodian (1991) and Sodian, Schneider & Perlmutter (1986) used a different clustering measure, the Ratio of Repetition (RR) which is a simple ratio measure of the proportion of repetitions to the total number of recalled items. The maximum amount of clustering is not set to 1.00 and therefore varies with different recall protocols. Murphy (1979) compared the relative effectiveness of many clustering measures and concluded that both the RR and the ARC were both unaffected by string length and the number of categories recalled, and that the two were highly correlated.

Murphy & Puff (1982) state that the ARC is undefined (incalculable score) if all the items recalled are from the same category, or if only one item is recalled from each category. This measure is therefore less useful with low levels of recall. The RR is only undefined if there are fewer than two items recalled. However because the maximum amount of clustering can vary with the recall protocol, RR scores for a child who recalled three items either all from one category, or one from each category, equalled 1.00. Whereas the RR score for a child who recalled all twelve cards with perfect category clustering, only equalled 0.82. It was therefore decided to use the ARC measure because classifying these subjects as 'undefined' was preferable to being assigned a disproportionately high clustering score.

Negative ARC scores have been criticised for not being proportionally equivalent to positive ARC scores. For example a score of -0.50 does not mean that clustering is midway between the minimum clustering possible and chance, in the same way as a score of 0.50 is the midway point between maximum clustering and chance. Therefore the Negative Adjusted Ratio of Clustering (NARC) formula was used if any negative scores resulted from the ARC formula. This substitutes the minimum possible repetitions for the maximum, and therefore calculates the proportion of actual category repetitions above chance to the minimum possible repetitions above chance. This therefore has the same properties as the positive scores i.e. a overall chance level of zero and a maximum lower band of -1.00 (Reonker, Thompson & Brown, 1971).

The children were further divided into three categories on the basis of their ARC clustering scores. Scores between 0.51 and 1.00 were classified as Extensively Strategic, scores between 0.01 and 0.50 were classified as Limited Strategic, and scores between -1.00 and zero were classified as Non-Strategic. Although this scoring procedure was to some extent arbitrary, there was no obvious alternative. Inspection of the order of items recalled showed that, those children classified as Extensively strategic showed either perfect clustering or only two or three deviations from this. Children classified as Limited Strategic tended to show some evidence of clustering although there were many more deviations, while those classified as Non-Strategic showed little evidence of clustering at all.

The meta-memory questions with regard to why they chose the grouped or mixed arrangement was classified into three categories.

1: Extensive Awareness - Reference to the grouped arrangement of the cards.

2: Limited Awareness - Reference to remembering; being better or easier; reference to liking the particular arrangement; matching the cards across the two arrangements and reference to the mixed arrangement not being in groups.

3: No Awareness - Reference to the number of cards; naming the cards; picking a particular card; "dont know" responses and irrelevant justifications.

For full details of the type of responses for each category see Appendix J.

Selective Attention Task

The total number of accurate same/different judgement across the four pairs of houses was calculated. If the child changed his/her mind the first answer they gave was taken as the child's response.

The strategies used for opening the windows were classified into three categories.

1: Exhaustively Strategic - Showing comparison between homologous pairs.

Opening homologous pairs; systematically opening all the windows in one house then all the windows in the other house, or systematically opening across houses in either horizontal rows or vertically i.e. opening homologous columns of windows. However for the latter two examples the child also checked back to the pictures in the first house while they opened the windows in the second.

2: Limited Strategic - Showing only limited comparison between picture pairs.

Opening all the windows in one house then all the windows in the other without checking back; opening across houses either horizontally or vertically without checking back; random searching within each house separately and opening one window then looking for it's picture pair in the other house.

3: Non-Strategic - Showing no comparison between picture pairs.

Opening the windows in just one house; random opening across both houses; and opening the columns of windows in turn but not homologous columns.

To be classified into one of these categories, eight out of the possible twelve windows had to be opened using the particular strategy. If six windows were opened by one strategy and the remaining six by another, the strategies used by the child to open the other pairs of houses were used to guide the decision. For Appendix K for an illustration of these different types of strategies.

The meta-awareness questions with regard to why the children thought the pairs of houses were the same or different were classified into three categories.

1: Extensive Awareness - Showing extensive comparison between matching picture pairs.

Pair 1 - stating they were all the same or matching pairs.

Pairs 2, 3 & 4 - stating they were different and pointing to at least one difference.

Pair 4 - stating they were the same and matching pictures. Reference to the differing locations of the pictures.

2: Limited Awareness - Showing limited comparisons between matching picture pairs.

Pairs 1 & 4 - stating they were the same but only matching one/some of the picture pairs, or pointing to all the pictures in one house.

Pairs 2 & 3 - stating they were the same then matching the similar picture pairs either ignoring the difference(s), or then pointing out the difference(s).

All Pairs - Giving both a correct and an incorrect justification.

3: No Awareness - Showing no comparison between matching picture pairs.

Pairs 1, 2 & 3 - matching non-homologous (different) pairs.

Pairs 2 & 3 - stating that they were all the same.

All Pairs - stating they were the same and pointing to one window; pointing to the house as a whole and not any particular window and pointing to all the windows in turn.

The reliability of all these measures are detailed in the Method section for Phase 3, Chapter 10.

8.1.6 DATA ANALYSIS

All between subjects proportional data, i.e. drawing ability, attention strategies, clustering categories, selective attention age differences, window opening strategies and all meta-awareness categories were analysed using the Chi-Square test for independent samples. Where the observed set of frequencies formed a 2 x 2 contingency table, the Yates correction for continuity was applied (Siegel & Castellan, 1988). If any of the expected cell frequencies were less than five the Fisher exact probability test was used (Siegel, 1956).

Within subjects proportional data, i.e. the task effects for the selective attention same/different responses were analysed using the Cochran Q test for related samples (Siegel, 1956). As no specific follow-up analysis was available the McNemar test for significant changes was used, however the significance level was set at 0.025 rather than 0.05. If the expected cell frequencies were less than five the Binomial test was used, again with a 0.025 significance level.

Analysis of Variance (ANOVA) was used to assess the amount of attention paid towards the drawing model, memory recall responses, ARC clustering scores and the total number of correct same/different responses for the selective attention task. Where the assumption of homogeneity of variance between conditions was not met, transformations were performed on the raw data according to the criteria detailed in Howell (1987). Significant differences were assessed using Scheffe's method of multiple comparison of means (See Appendix A for full details).

In order to assess the relationships between the measures of performance, strategy use and metacognitive awareness within each of the three tasks, the Gamma statistic for ordinally scaled variables was used (Siegel & Castellan, 1988). However due to memory recall performance being a score and not an categorical ordered variable, the relationship between this and the other two measures was assessed using Spearman's correlation coefficient.

In order to assess variations across the three tasks, Pearson Product Moment correlations and Friedman two-way analysis of variance by ranks were used. For assessment of performance levels, the dependent variables were varied i.e. categorical for the drawing task, a score out of twelve for the memory task, and a score out of four for the selective attention task. Therefore Point Biserial correlations compared the drawing task with the other two measures, and Pearson's correlation compared the memory and selective attention tasks. For assessment of strategic abilities and awareness levels, both of these measures were categorical data which were equivalent across the three tasks. The Friedman test was therefore used as each child's performance could be ranked across the three tasks, in order to assess whether or not the ranking of tasks varied systematically.

8.2 RESULTS

The following sections detail of the main findings of the analyses. The full analysis of variance summary tables and details of the subsidiary results are given in Appendix L.

8.2.1 DRAWING TASK

8.2.1.1 DRAWING DATA

The number of children in each age group producing the different categories of drawings in response to the two models are detailed in Table 8.2.

Cup Drawing

There were no significant differences between the three age groups (ps>.05) for this drawing model. The four- and five-year-olds therefore did not show significantly lower proportions of visually realistic drawings than the six-year-olds, and subsequently performed relatively well on this task.

Ball Drawing

A greater proportion of six-year-olds produced visually realistic drawings than both the four- and five-year-olds (Fisher Exact Test ps<.01). The four- and five-year-olds did not show any significant difference in the proportion of their intellectually and visually realistic drawings (Fisher Exact Test p>.05).

Comparison Across Tasks

A Phi correlation coefficient was calculated in order to compare the relationship between a child being classified as either intellectually or visually realistic on each of the two tasks. This correlation was significant ($r_{ø}$=0.64 d.f.=48 p<.01), in that most children showed comparable performance across tasks i.e. they generally produced intellectually realistic drawings of both models. Fisher tests also confirmed this pattern of results overall combining all ages (p<.001).

TABLE 8.2 FREQUENCY OF DRAWINGS FOR EACH MODEL

	CUP DRAWING			BALL DRAWING			
Age	Visually Realistic	Intellectually Realistic	Scribble	Visually Realistic	Intellectually Realistic	Omission	Scribble
4	5	11	4	1	15	2	2
5	4	16	0	1	16	2	1
6	10	10	0	9	10	1	0

TABLE 8.3 COMPARISON OF PERFORMANCE ACROSS DRAWING MODELS

	BALL VISUAL REALISM (V.R.)		BALL INTELLECTUAL REALISM (I.R.)	
AGE	CUP V.R.	CUP I.R.	CUP V.R.	CUP I.R.
4	1	0	2	11
5	0	1	2	14
6	8	1	1	9
TOTAL	9	2	5	34

Fisher tests for the individual ages revealed that the 4- and 5-year-olds showed no significant differences across tasks (Fisher Exact Test $p>.05$). However inspection of the data in Table 8.3 shows that most children were intellectually realistic on both tasks. For the 6-year-olds, significantly more children were either intellectually or visually realistic on both tasks (Fisher Exact Test $p<.001$). The children therefore showed equivalent performance on both the cup and ball tasks.

8.2.1.2 ATTENTIONAL DATA

8.2.1.2.1 Number of Looks

A 3 (age) x 2 (gender) x 2 (drawing order) x 2 (drawing model) x 4 (look type) analysis of variance was performed on the number of times each child looked at the model in front of them. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

This showed no significant main effect of age ($F(2,48)=2.15$ $p>.05$). The mean number of looks for the three age groups were 0.49, 0.59 and 0.51 for the four-, five- and six-year-olds respectively.

The main effect of drawing model proved to be insignificant ($F(1,48)=2.85$ $p>.05$), therefore there was no difference in looking behaviour towards the two models. This effect did however significantly interact with drawing order ($F(1,48)=13.04$ $p<.01$). As detailed in Table 8.4, follow-up analysis showed that the children paid more attention to the ball model when it was presented first, compared to when it was presented second (Scheffe $F(1,48)=18.06$ $p<.05$), and a reduction in looking occurred between the first and second drawings with the cup/ball order (Scheffe $F(1,48)=12.54$ $p<.05$). Therefore the cup model retained the same level of attention irrespective of whether it was presented first or second, while the ball model showed reduced attention when presented second.

The ANOVA showed a highly significant main effect of look type ($F(2,117)=218.55$ $p<.001$*). As illustrated in Figure 8.5, significantly more looks occurred at the

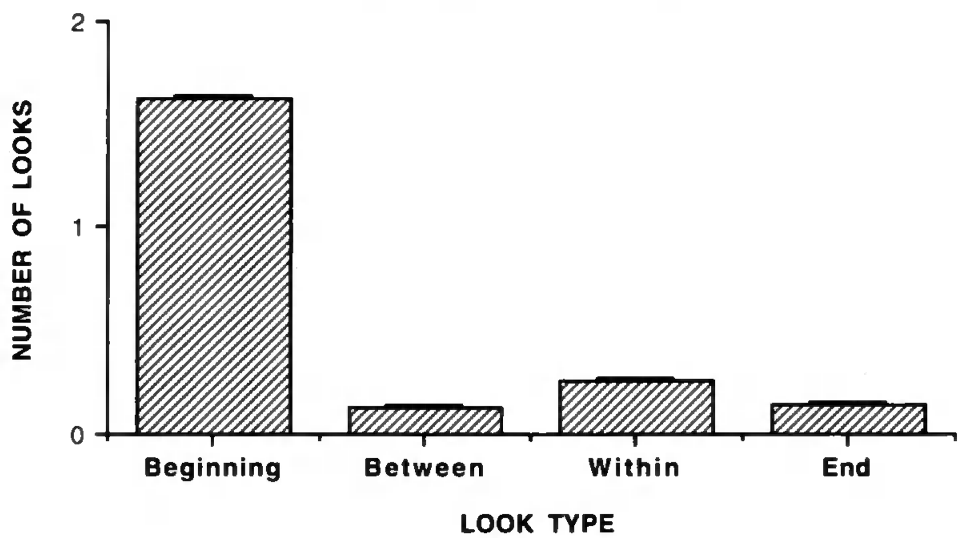
*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 8.4 MEAN NUMBER OF LOOKS PER DRAWING MODEL AND DRAWING ORDER

DRAWING MODEL DRAWING ORDER	N	BALL	CUP	MEAN TOTAL
BALL/CUP	60	0.16 (0.62)	0.14 (0.54)	0.15 (0.56)
CUP/BALL	60	0.10 (0.36)	0.14 (0.65)	0.19 (0.50)
MEAN TOTAL		0.13 (0.48)	0.14 (0.59)	

Untransformed means (number of looks) are shown in parentheses.

FIGURE 8.5 MAIN EFFECT OF LOOK TYPE FOR NUMBER OF LOOKS MEASURE



'beginning' of the task compared to all other look types (Scheffe ps<.001). The mean number of looks were 1.63, 0.13, 0.26 and 0.14 for the 'beginning', 'between', 'within' and 'end' look types respectively.

Number of Looks and Drawing Realism

Two, 3 (age) x 2 (drawing realism) analyses of variance, one for each model, were performed in order to compare the number of looks of the visually and intellectually realistic drawers. Due to unequal variances and the standard deviations being proportional to the means, log(10) transformations were performed on the data.

For the cup drawing the ANOVA showed the main effect of drawing realism approaching significance ($F(1,50)=3.74$ $p=.059$), with the means in the hypothesised direction (mean number of looks = 0.72 for the visually realistic drawers and 0.59 for the intellectually realistic drawers).

This ANOVA also revealed a significant main effect of age ($F(2,50)=4.37$ $p<.05$). Follow-up analysis revealed that the five-year-olds looked at the model more than the six-year-olds (Scheffe $F(2,50)=11.95$ $p<.01$). The mean number of looks were 0.62, 0.83 and 0.51 for the 4-, 5- and 6-year-olds respectively). This was therefore different to the main analysis and to the findings of the previous studies. However this ANOVA was only performed on those children who could be classified as intellectually or visually realistic and not on the sample as a whole. Although this effect of age seems to have been caused by a few subjects, the four five-year-olds who produced a visually realistic drawing all showed consistently high levels of attention towards the model. This was therefore consistent with the prediction that increased attention would be associated with producing a visually realistic drawing.

The ANOVA also showed a main effect of look type ($F(2,122)=80.69$ $p<.001$*) and more importantly an interaction between look type and drawing realism ($F(2,122)=3.96$ $p<.05$*). Follow-up analysis revealed that, like the main analysis, the 'beginning' looks

*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

were greater than all other look types (Scheffe ps<.001), and that this pattern of results was evident for both types of drawers. However it was noted that the visually realistic drawers showed a trend towards continually checking the model while they drew i.e. high levels of 'within' looking. See Table 8.5 and Figure 8.6 for further details of this effect.

The ANOVA on the ball drawing showed no significant main effect of drawing realism ($F(1,46)=2.65$ $p>.05$). However this analysis was possibly affected by low subject numbers, in particular there was only one 4- and one 5-year-old visually realistic drawer. The means were however in the predicted direction i.e. 0.42 seconds for the intellectually realistic drawers and 0.63 seconds for the visually realistic drawers.

8.2.1.2.2 Looking Time

A 3 (age) x 2 (gender) x 2 (drawing order) x 2 (drawing model) x 4 (look type) analysis of variance was performed on the time each child spent looking at the model in front of them. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

The ANOVA showed no significant main effects of age ($F(2,48)=0.98$ $p>.05$) or drawing model ($F(1,48)=0.78$ $p>.05$), however these two factors did significantly interact ($F(1,48)=20.55$ $p<.001$). As detailed in Table 8.6, the five-year-olds paid more attention to the cup model, than they did to the ball model (Scheffe $F(1,48)=16.31$ $p<.05$). The other two age groups did not show any significant difference in the amount of attention they paid towards the two models (Scheffe ps>.05).

The ANOVA also showed a significant interaction between drawing model and drawing order ($F(1,48)=20.55$ $p<.001$). As detailed in Table 8.7, follow-up analysis showed the same pattern of results as the Number of Looks measure. The children paid more attention to the ball model when it was presented first compared to when it was presented second (Scheffe $F(1,48)=16.99$ $p<.05$). When the child was presented with the cup/ball order there was a reduction in looking from the first to the second task (Scheffe $F(1,48)=16.99$ $p<.05$) but not with the ball/cup order. See Figure 8.7 an illustration of this effect.

TABLE 8.5 MEAN NUMBER OF LOOKS PER DRAWING REALISM AND LOOK TYPE (CUP TASK)

LOOK TYPE REALISM	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
INTELLECTUAL	37	0.42 (1.83)	0.06 (0.18)	0.05 (0.23)	0.03 (0.11)	**0.14 (0.59)**
VISUAL	19	0.43 (1.80)	0.00 (0.00)	0.19 (0.77)	0.08 (0.32)	**0.18 (0.72)**
MEAN TOTAL		**0.41 (1.82)**	**0.04 (0.09)**	**0.10 (0.50)**	**0.04 (0.21)**	

Untransformed means (number of looks) are shown in parentheses.

TABLE 8.6 MEAN LOOKING TIME PER AGE AND DRAWING MODEL

MODEL	4 YEARS	5 YEARS	6 YEARS	MEAN TOTAL
BALL	0.16 (0.83)	0.15 (0.72)	0.18 (0.87)	**0.17 (0.80)**
CUP	0.16 (0.80)	0.21 (1.07)	0.15 (0.67)	**0.17 (0.84)**
MEAN TOTAL	**0.16 (0.81)**	**0.18 (0.88)**	**0.17 (0.77)**	

Untransformed means (seconds) are shown in parentheses.

TABLE 8.7 LOOKING TIME PER DRAWING MODEL AND DRAWING ORDER

DRAWING MODEL DRAWING ORDER	N	BALL	CUP	MEAN TOTAL
BALL/CUP	60	0.19 (0.97)	0.16 (0.72)	0.18 (0.83)
CUP/BALL	60	0.14 (0.65)	0.18 (0.98)	0.16 (0.81)
MEAN TOTAL		0.17 (0.80)	0.17 (0.84)	

Untransformed means (seconds) are shown in parentheses.

FIGURE 8.6 CUP MODEL - INTERACTION OF DRAWING REALISM BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE

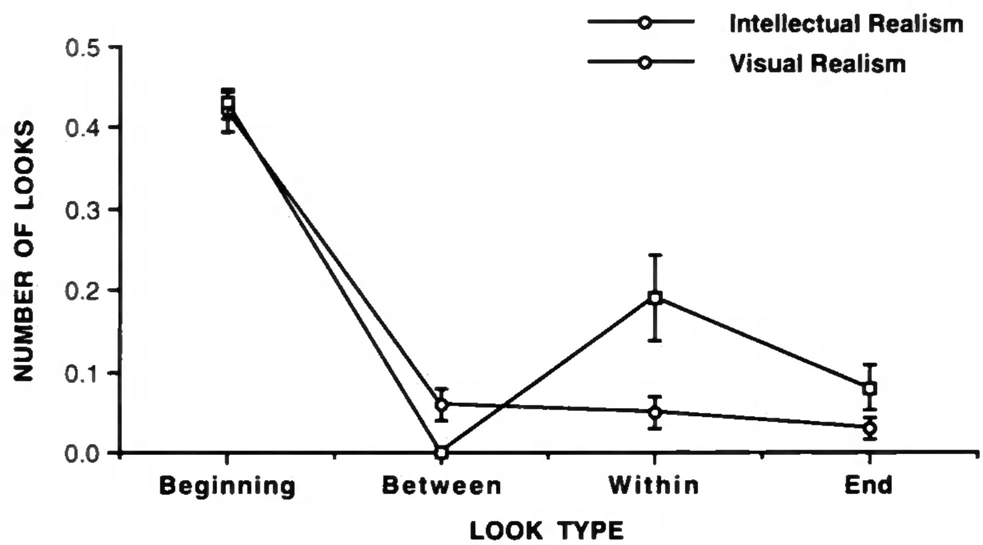
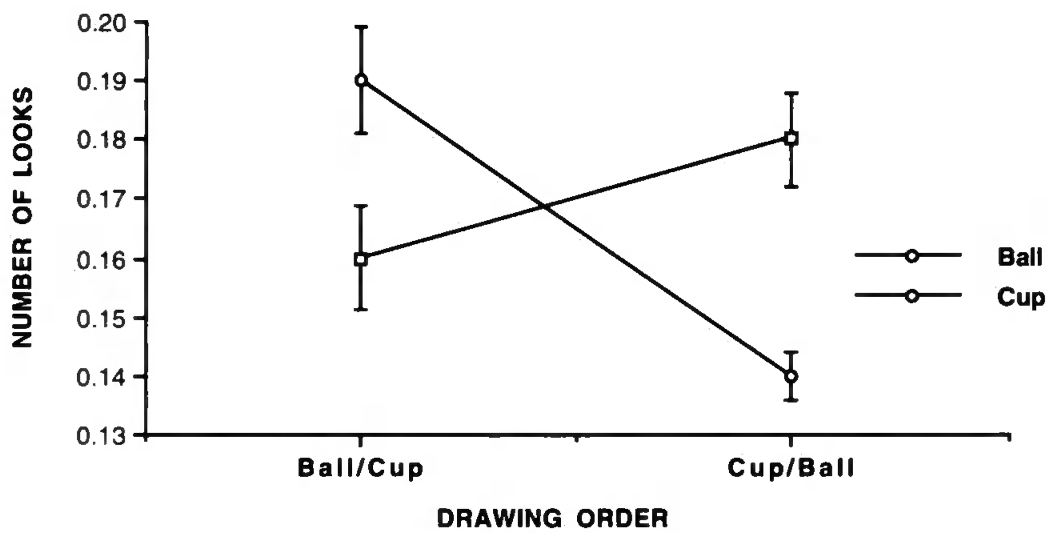


FIGURE 8.7 INTERACTION OF DRAWING MODEL BY DRAWING ORDER FOR LOOKING TIME MEASURE



The ANOVA showed a highly significant main effect of look type ($F(2,119)=453.31$ $p<.001$*), in that significantly more time was spent looking at the 'beginning' of the task compared to all other look types (Scheffe ps<.001) (mean seconds = 2.86, 0.10, 0.25 and 0.10 for the 'beginning', 'between', 'within' and 'end' look types respectively).

Looking Time and Drawing Realism

Two, 3 (age) x 2 (drawing realism) analyses of variance, one for each model, were performed in order to compare the looking time of the visually and intellectually realistic drawers. Due to unequal variances and the standard deviations being proportional to the means, log(10) transformations were performed on the data.

For the cup drawing the ANOVA showed a significant main effect of drawing realism ($F(1,50)=8.34$ $p<.01$). The visually realistic drawers looked at the model more than the intellectually realistic drawers. The ANOVA also showed a significant interaction between look type and drawing realism ($F(3,150)=2.81$ $p<.05$), although this interaction was non-significant with the epsilon correction for within-subject factors. Scheffe follow-up analysis revealed that the 'beginning' looks were greater than all other look types for both types of drawers. However the visually realistic drawers showed a trend towards higher levels of 'within' looking. See Table 8.8 and Figure 8.8 for further details.

The ANOVA on the ball drawing showed a significant main effect of drawing realism ($F(1,46)=6.68$ $p<.05$), in that the visually realistic drawers spent more time looking at the model than the intellectually realistic drawers. However again this analysis may have been affected by low subject numbers. As can been seen from Table 8.9, the one four-year-old who produced a visually realistic drawing, showed a high level of attention towards the drawing model. Although this one subject has inflated the visually realistic mean, this child's behaviour is consistent with the hypothesis that increased attention leads to increased performance, even at this young age. Unlike the cup model there was no interaction between look type and drawing realism ($F(2,108)=2.42$ $p>.05$*).

*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 8.8 **MEAN LOOKING TIME PER DRAWING REALISM AND LOOK TYPE (CUP TASK)**

LOOK TYPE REALISM	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
Intellectual	37	0.54 (2.73)	0.04 (0.12)	0.05 (0.23)	0.02 (0.06)	**0.16** **(0.78)**
Visual	19	0.59 (3.10)	0.00 (0.00)	0.19 (0.74)	0.08 (0.34)	**0.22** **(1.05)**
MEAN TOTAL		**0.55** **(2.91)**	**0.03** **(0.06)**	**0.09** **(0.49)**	**0.03** **(0.20)**	

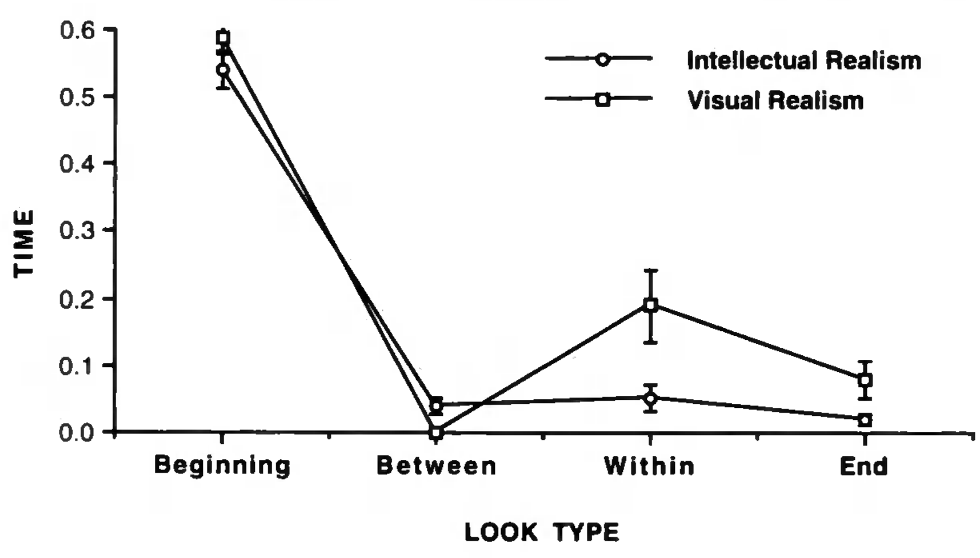
Untransformed means (seconds) are shown in parentheses.

TABLE 8.9 **MEAN LOOKING TIME PER DRAWING REALISM AND AGE (BALL TASK)**

AGE REALISM	N	4 YEARS	N	5 YEARS	N	6 YEARS	MEAN TOTAL
Intellectual	15	0.15 (0.76)	16	0.15 (0.71)	10	0.15 (0.68)	**0.15** **(0.72)**
Visual	1	0.27 (1.51)	1	0.17 (0.96)	9	0.21 (1.05)	**0.22** **(1.17)**
MEAN TOTAL		**0.21** **(1.13)**		**0.16** **(0.84)**		**0.18** **(0.87)**	

Untransformed means (seconds) are shown in parentheses.

FIGURE 8.8 **CUP MODEL - INTERACTION OF DRAWING REALISM BY LOOK TYPE FOR LOOKING TIME MEASURE**



Number of Looks and Looking Time

In order to assess the relationship between the two measures of attention, Pearson Product Moment partial correlations were performed on each child's total number of looks and looking time, separately for each task. Partial correlations were used in order to control for any possible age effects. These showed positive correlations of $r=0.58$ and 0.65 (d.f.=57 $ps<.001$) for the ball and cup tasks respectively.

8.2.1.3 STRATEGIES OF ATTENTION

Based on the children's strategic attention towards the drawing model, they were divided into three groups i.e. extensively strategic, limited strategic and non-strategic. Table 8.10 details the number of children in each category for each drawing model. For the cup task there were no significant differences between the three categories and age groups (Fisher Exact Test $ps>.05$). For the ball task, the four-year-olds showed high levels of non-strategic behaviour, the five-year-olds high levels of limited strategic behaviour, and the six-year-olds a combination of non-strategic and exhaustively strategic behaviour (Fisher Exact Test $ps<.05$). However due to the fairly simple nature of the ball task it is quite possible that the older children were capable of drawing this model without continued reference to it, and therefore showed lower than expected levels of strategic behaviour.

The four- and five-year-olds seem to have adopted a higher level of strategic attention for the cup task, i.e. 'within' and 'between' looking. A ball is a uniform shape whereas a cup can vary considerably. Therefore it is possible that the children felt that they needed to attend to the cup model while they drew, in order to accurately represent its shape.

8.2.1.4 META-AWARENESS QUESTIONS

Table 8.11 details the number of children, for each model and age group, responding either "yes" or "no" to the question of whether they thought they would be able to draw the model even if it was hidden from view. Goodness of Fit tests show all these differences to be significant ($ps<.01$). In total only 6% of children thought that they would *not* be able to draw, either or both, the cup and balls if they were hidden from view.

TABLE 8.10 STRATEGIC ATTENTIONAL CATEGORIES

CATEGORY AGE	EXTENSIVELY STRATEGIC	LIMITED STRATEGIC	NON-STRATEGIC	TOTAL
CUP				
4	7	6	7	20
5	9	5	6	20
6	5	7	8	20
TOTAL	21	18	21	
BALL				
4	2	4	14	20
5	3	10	7	20
6	8	3	9	20
TOTAL	13	17	30	

TABLE 8.11 YES/NO RESPONSES

		BALL		CUP	
AGE	N	YES	NO	YES	NO
4 YEARS	20	16	4	16	4
5 YEARS	20	19	1	18	2
6 YEARS	20	18	2	19	1
TOTAL		53	7	53	7

Table 8.12 details the number of children in each of the three awareness categories. These relate to the children's justifications of why they thought they would/would not still be able to draw the models. See Appendix J for full details of these categories. For the cup task, the four-year-olds showed a lack of awareness of the strategic importance of attending to the model, compared to the six-year-olds (Fisher Exact Test $ps<.05$). The proportion of six-year-olds was fairly even across the three levels of strategic behaviour. For the ball drawing, the four-year-olds again showed high levels of no awareness, the five-year-olds high levels of both no awareness and limited awareness, and the six-year-olds high levels of both limited and extensive awareness of attending to the model (Fisher Exact Test $ps<.05$).

It was noted that the four 5- and 6-year-olds who answered "no" to the original question, stated that the reason why they would not still be able to draw the models was due to not being able to attend to it. They therefore showed extensive awareness of the strategic importance of attending to the model.

8.2.1.5 ASSOCIATION BETWEEN MEASURES

In order to assess the relationship between the children's drawing performance, strategy use and meta-cognitive awareness of the attentional strategy, the Gamma statistic for ordinally scaled variables was used (Siegel & Castellan, 1988). Table 8.13 details these associations separately for each age group and both drawing models. In general these showed that the children who felt that they would *not* be able to draw the model if it was hidden from view, were able to justify this decision by referring to the necessity of attending to the model.

More specifically, for the cup drawing the four-year-olds showed a significant positive association between drawing realism and attentional strategy used ($G= +0.58$ $p<.05$). Increased levels of strategic attention was associated with increased levels of drawing realism. There was a significant association between the children's "yes/no" response and their justification of this ($G= +0.80$ $p<.05$), with the majority of children stating that they would be able to draw the cup without it in front of them, but having no awareness of

TABLE 8.12 META-AWARENESS CATEGORIES

CATEGORY AGE	EXTENSIVE AWARENESS	LIMITED AWARENESS	NO AWARENESS	TOTAL
CUP				
4	0	7	13	20
5	4	6	10	20
6	7	7	6	20
TOTAL	11	20	29	
BALL				
4	0	6	14	20
5	2	9	9	20
6	7	8	5	20
TOTAL	9	23	28	

TABLE 8.13 GAMMA ASSOCIATIONS BETWEEN MEASURES

MEASURE AGE	DRAWING REALISM	ATTENTIONAL STRATEGY	YES/NO
CUP DRAWING			
4 YEARS			
STRATEGY	+0.58 *		
YES/NO	-0.51	+0.00	
AWARENESS	-0.65 *	+0.21	+0.80 *
5 YEARS			
STRATEGY	+0.36		
YES/NO	-1.00 **	-0.63 *	
AWARENESS	-0.63 *	-0.04	+1.00 **
6 YEARS			
STRATEGY	-0.31		
YES/NO	+1.00 **	-1.00 **	
AWARENESS	+0.29	+0.04	+1.00 **
BALL DRAWING			
4 YEARS			
STRATEGY	+0.24		
YES/NO	-0.28	+0.50	
AWARENESS	-0.03	-0.50	-0.15
5 YEARS			
STRATEGY	-0.10		
YES/NO	+0.50	+0.40	
AWARENESS	+0.90 **	+0.17	+1.00 **
6 YEARS			
STRATEGY	+0.42		
YES/NO	+0.16	+0.05	
AWARENESS	-0.08	+0.49 †	+1.00 **

† $p=0.05$
* $p<0.05$
** $p<0.01$

why they could do this. This age group showed a negative association between drawing realism and awareness of the effective strategy (G= -0.65 $p<.05$), in that increased realism related to reduced awareness. Meta-awareness assessment of young children is however often criticised, as strategy use could occur without conscious awareness and/or the ability to verbalise the basis of this behaviour.

The five-year-olds showed significant associations between the "yes/no" response and the other three measures. The majority of children responded "yes" and were intellectually realistic in their drawing ability (G= -1.00 $p<.01$), used an extensive attentional strategy (G= -0.63 $p<.05$), and had limited awareness of why they thought they could still draw the model. The two children who responded "no" showed extensive awareness of the facilitatory effect of attending to the model (G= +1.00 $p<.05$). There was also a negative association between drawing realism and awareness of this strategy (G= -0.63 $p<.05$), in that increased realism related to reduced awareness.

The six-year-olds only showed significant associations between the "yes/no" response and the other three measures. All the children who responded "yes" were intellectually realistic (G= +1.00 $p<.01$), they varied across the three attentional strategies (G= -1.00 $p<.01$) and awareness categories (G= +1.00 $p<.01$), while the one child who answered "no" was visually realistic, non-strategic and had extensive awareness of not being able to draw the model without continued attention towards it.

For the ball drawing, the four-year-olds showed no significant associations between measures. The five-year-olds showed significant positive associations between awareness and both drawing realism (G= +0.90 $p<.01$) and the "yes/no" response (G= +1.00 $p<.01$). Increased realism was associated with increased awareness. Limited awareness was associated with answering "yes" to the original meta-cognitive question, while the one child who answered "no" had extensive awareness of the attentional strategy.

For the six-year-olds, the association between strategy use and awareness was only just significant (G= +0.49 $p=.05$). This showed a general pattern of increased strategy use relating to increased awareness of the usefulness of this strategy. They showed a significant association between the "yes/no" response and awareness (G= +1.00 p<.01), in that the children responding "yes" varied across the different categories, while the two children who responded with "no" had extensive awareness of the attentional strategy.

Summary of Main Findings (Drawing Task)

1: The six-year-olds produced more visually realistic drawings than the four- and five-year olds for the ball task alone. The majority of children were intellectually realistic on both tasks.

2: The three age groups showed comparable levels of attention towards the drawing model, with the majority of looking occurring at the 'beginning' of the task. The cup model however seems to have retained the child's interest when presented second, for all ages.

3: The visually realistic drawers of all ages, generally paid more attention towards the models than the intellectually realistic drawers. They showed trends towards higher levels of 'within' looking for the cup model, which would be consistent with an extensive attentional strategy.

4: There was a general developmental increase in the use of extensive strategic attention towards the drawing model, however the older age group do not seem to have used the effective strategy to any greater extent, possibly due to the simplicity of the tasks.

5: There was a general developmental increase in the children's awareness of the extensive attentional strategy.

6: The most consistent association was between the "yes/no" response and the justification of this. Particularly for the five- and six-year-olds, the few children who thought that they would not be able to draw the model if it was hidden from view while they were actually drawing, were able to justify this decision by referring to the necessity of strategically attending to the model.

8.2.2 MEMORY TASK

8.2.2.1 RECALL RESPONSES

An initial one-way within subjects analysis of variance was performed in order to determine whether there was any significant difference between the children's recall responses for the two different sets of cards. Due to equal variances and a normal distribution, no transformation was necessary. The set of cards proved to be an insignificant factor ($F(1,59)=2.82$ $p>.05$). The mean recall score for the 'T' set was 5.32 (standard deviation 2.7) and for the 'H' set 4.75 (standard deviation 2.6), out of the possible twelve. The results were therefore pooled across the two sets of cards in the remaining analyses.

A 3 (age) 2 (gender) x 2 (presentation order) x 2 (display type) analysis of variance was performed on each child's recall scores. Due to unequal variances and a narrow range of scores, the number of correctly recalled cards was divided by the total number possible i.e. twelve, and an arcsine transformation performed on this proportional score. This revealed a significant main effect of age ($F(2,48)=36.35$ $p<.001$). Scheffe follow-up analysis showed that the 6-year-olds recalled more items than the 5-year-olds, who in turn recalled more than the four-year-olds (Scheffe $ps<.01$).

The ANOVA also showed a significant main effect of display type ($F(1,48)=32.02$ $p<.001$), in that the grouped display type led to significantly more pictures being recalled than the mixed display type (mean number of cards recalled = 5.67 and 4.40 respectively). This factor also interacted with age ($F(2,48)=8.52$ $p<.01$) revealing that this pattern of results was only evident for the 6-year-olds (Scheffe $F(2,48)=48.92$ $p<.001$), while the 4- and 5-year-olds showed no significant difference between the two display types (Scheffe $ps>.05$). This effect is detailed in Table 8.14 and illustrated in Figure 8.9.

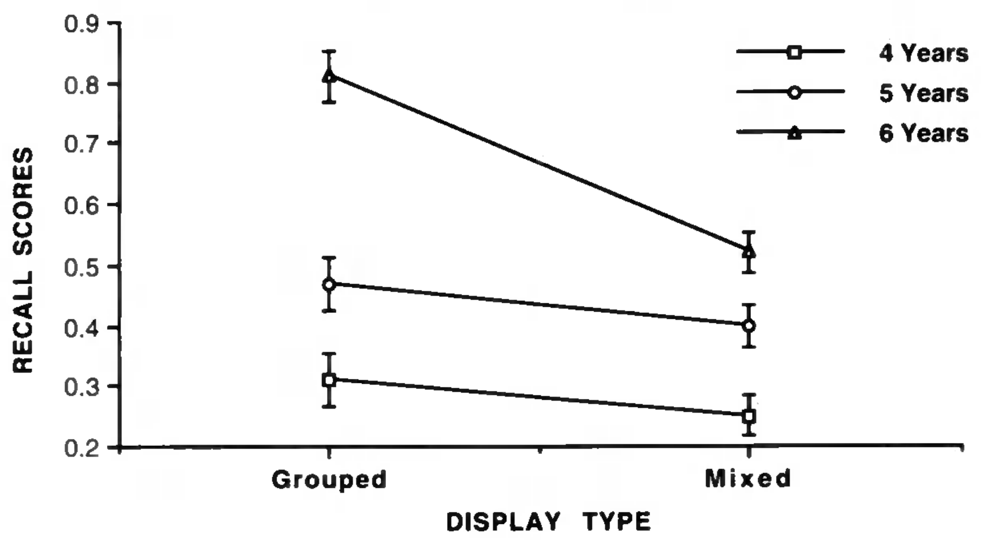
Display type also interacted with the order of presentation ($F(1,48)=19.39$ $p<.001$) and these two factors further interacted with age ($F(2,48)=3.50$ $p<.05$). See Table 8.14 for details of these means. Follow-up analysis showed that for the grouped display type there

TABLE 8.14 MEAN RECALL SCORES PER DISPLAY TYPE, PRESENTATION ORDER AND AGE

DISPLAY TYPE	ORDER	N	4 YEARS	N	5 YEARS	N	6 YEARS	MEAN TOTAL
Mixed	Mixed/ Grouped	10	0.30 (3.50)	9	0.51 (5.75)	10	0.59 (6.71)	**0.47 (5.32)**
	Grouped/ Mixed	10	0.20 (2.30)	11	0.29 (3.45)	10	0.45 (5.20)	**0.31 (3.65)**
TOTAL			**0.25 (2.90)**		**0.40 (4.60)**		**0.52 (5.96)**	
Grouped	Mixed/ Grouped	10	0.33 (3.80)	9	0.48 (5.33)	10	0.68 (7.42)	**0.50 (5.52)**
	Grouped/ Mixed	10	0.30 (3.50)	11	0.45 (5.20)	10	0.92 (9.40)	**0.56 (6.03)**
MEAN TOTAL			**0.31 (3.65)**		**0.47 (5.27)**		**0.81 (8.41)**	

Untransformed means (number of cards recalled) are shown in parentheses.

FIGURE 8.9 INTERACTION OF AGE BY DISPLAY TYPE FOR MEMORY RECALL SCORES



was no significant difference between being presented first (grouped/mixed order) or second (mixed/grouped order) (Scheffe $F(1,48)=3.14$ $p>.05$), while for the mixed display type the children recalled more items if this had been presented first (mixed/grouped order) (Scheffe $F(1,48)=22.31$ $p<.01$). Consequently if the child was presented with the grouped and then the mixed display type there was a significant decline in performance (Scheffe $F(1,48)=56.35$ $p<.001$). This effect is illustrated in Figure 8.10. Follow-up analysis of the three way interaction showed that the latter effect was only evident with the 6-year-olds (Scheffe $F(2,48)=64.33$ $p<.01$).

8.2.2.2 ARC CLUSTERING

A 3 (age) x 2 (presentation order) x 2 (display type) analysis of variance was performed on the ARC clustering scores. Due to unequal variances and a proportional score, an arcsine transformation was performed. Those children who's ARC scores were undefined (recalled from only one category, or just one card from each category recalled) were entered in to the analyses as 'missing data'. This showed a significant main effect of display type ($F(1,33)=10.81$ $p<.01$), where the grouped display type led to greater clustering at recall than the mixed display type (mean ARC scores = +0.52 and -0.01 respectively). This factor did not significantly interact with age ($F(2,33)=1.56$ $p>.05$), suggesting that this effect was evident at all ages.

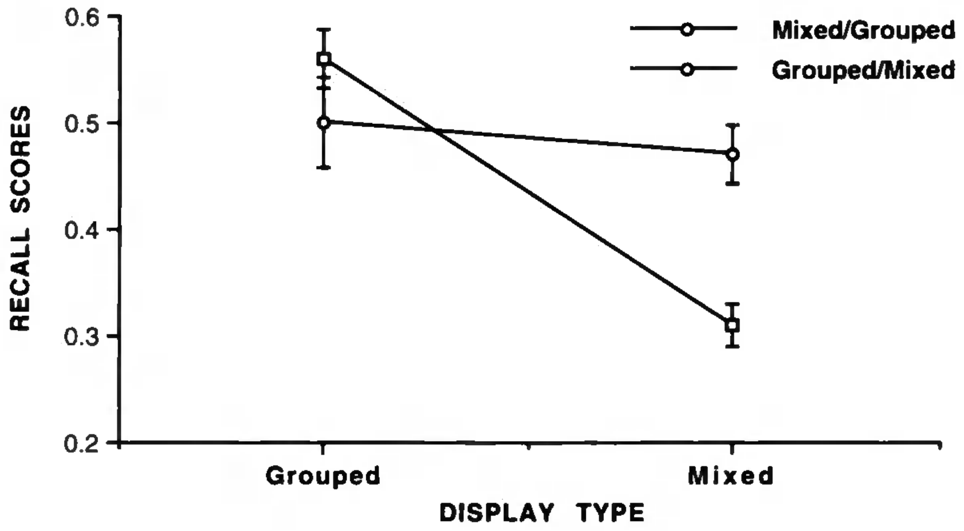
8.2.2.3 CLUSTERING CATEGORIES

Based on their ARC score the children were divided into three groups i.e. extensively strategic, limited strategic and non-strategic. Table 8.15 details the number of children in each category for each display type. For the mixed display type there were no significant differences between the three strategic categories and age groups (Fisher Exact Test $ps>.05$), with the majority of children either being non-strategic or only limited in their strategic ability. Fifty-five percent of the four-year-olds were undefined. For the grouped display type there was one significant difference in that the six-year-olds were limited in their strategy use, while the four- and five-year-olds were generally non-strategic (Fisher Exact Test $p<.001$).

TABLE 8.15 STRATEGIC CLUSTERING CATEGORIES

CATEGORY AGE	EXTENSIVELY STRATEGIC	LIMITED STRATEGIC	NON-STRATEGIC	UNDEFINED	TOTAL
MIXED					
4	1	2	6	11	20
5	2	4	9	5	20
6	3	10	7	0	20
TOTAL	6	16	22	16	
GROUPED					
4	5	2	4	9	20
5	9	2	4	5	20
6	14	5	1	0	20
TOTAL	28	9	9	14	

FIGURE 8.10 INTERACTION OF PRESENTATION ORDER BY DISPLAY TYPE FOR MEMORY RECALL SCORES



8.2.2.4 RECALL PERFORMANCE AND CLUSTERING CATEGORIES

Two, 3 (age) x 3 (category) analyses of variance, one for each display type, were performed on the arcsine transformed recall scores, in order to compare the relationship between recall performance and the use of the clustering strategy at recall. There were no significant main effects of clustering category for either the mixed or the grouped display type ($F(2,37)=1.24$ and $F(2,35)=2.90$ respectively, $ps>.05$). Therefore recall scores did not vary significantly with the clustering category based on the ARC scores.

8.2.2.5 META-MEMORY QUESTIONS

Table 8.16 details the number of children in each age group who responded with either 'grouped', 'mixed', 'neither', 'don't know' or 'did not understand', to the question of which arrangement would help them remember the cards. Fisher exact probability tests on the grouped and mixed responses showed that more 6-year-olds chose the grouped arrangement than both the 4- and 5-year-olds ($ps<.05$). The 4- and 5-year-olds only differed with regard to the 'did not understand' and 'grouped' responses.

Table 8.17 details the number of children in each of the three awareness categories. These relate to the children's justifications of why they thought the arrangement they had chosen would help them to remember the cards. See Appendix J for full details of these categories. In general the 4-year-olds showed no awareness of how categorical clustering could aid recall, the 5-year-olds showed some limited awareness, while the 6-year-olds showed extensive awareness of this mnemonic strategy (Fisher Exact Test $ps<.01$).

Ten out of the eighteen 6-year-olds who selected the grouped arrangement showed extensive awareness of how this would help them remember the cards. The 5-year-olds selecting the grouped arrangement showed very similar patterns of responding to those who picked the mixed arrangement. The majority of 4-year-olds did not seem to understand the task and just selected individual cards, therefore resulting in a high proportion of 'did not understand' responses to the original choice of arrangement, and 100% categorisation into the 'no awareness' category.

TABLE 8.16 GROUPED/MIXED CHOICE

AGE	GROUPED	MIXED	NEITHER	DONT KNOW	DID NOT UNDER-STAND
4 YEARS	4	5	0	2	9
5 YEARS	9	7	1	0	3
6 YEARS	18	2	0	0	0
TOTAL	31	14	1	2	12

TABLE 8.17 META-AWARENESS CATEGORIES

CATEGORY AGE	EXTENSIVE AWARENESS	LIMITED AWARENESS	NO AWARENESS	TOTAL
4 YEARS	0	0	20	20
5 YEARS	1	8	11	20
6 YEARS	10	4	6	20
TOTAL	11	12	37	

8.2.2.6 ASSOCIATION BETWEEN MEASURES

Table 8.18 details the results of the associations between measures. Spearman correlation coefficients (r_S) were used to compare the relationship between recall performance and the clustering categories, the selection of the mixed or grouped arrangement, and the awareness categories. Comparisons between the latter three measures were assessed using the Gamma statistic for ordered variables. All these associations were assessed separately for the two display types and the three age groups. In general, although the younger children showed how increased clustering of items aided their recall ability, it was not until later that they developed an awareness of this mnemonic strategy.

More specifically, the four-year-olds showed a significant correlation between recall and clustering categories for the grouped display type (r_S =0.68 n=11 p<.05), therefore increased clustering aided recall performance. They also showed a significant association between the mixed/grouped choice and clustering categories for both display types although it only just reached significance for the mixed display type (G= +0.71 p=.05 and G= +0.73 p<.05 respectively). The majority of children who were unable to chose which arrangement would aid performance, were not using the clustering strategy at recall.

The five-year-olds showed no significant correlations between recall and the other measures. There was a significant negative association between clustering category and awareness of the clustering strategy (G= -0.63 p<.05). Increased clustering at recall related to reduced awareness of the strategy. Finally there was an association between the mix/grouped choice and the awareness category (G= +0.75 p<.01), in that the inability to make the choice was associated with no awareness, while selecting the mixed arrangement was associated with no or limited awareness, and selecting the grouped arrangement was associated with all three awareness categories.

For the six-year-olds there were no significant correlations between recall and the other measures. The grouped display typed showed a significant association between the

TABLE 8.18 CORRELATIONS AND GAMMA ASSOCIATIONS BETWEEN MEASURES

DISPLAY TYPE	MIXED		GROUPED		
MEASURE	RECALL (r_s)	CLUSTERING CATEGORY (Gamma)	RECALL (r_s)	CLUSTERING CATEGORY (Gamma)	MIXED/ GROUP (Gamma)
4 YEARS					
CLUSTERING	+0.55		+0.68 *		
MIX/GROUP	-0.22	+0.71 †	-0.15	+0.73 *	
AWARENESS	/	/	/	/	/
5 YEARS					
CLUSTERING	-0.21		+0.02		
MIX/GROUP	+0.02	+0.13	+0.06	+0.27	
AWARENESS	-0.06	-0.63 *	+0.16	-0.18	+0.75 **
6 YEARS					
CLUSTERING	-0.01		+0.36		
MIX/GROUP	+0.01	+0.43	-0.29	-1.00 **	
AWARENESS	+0.08	-0.51 *	+0.28	-0.44	+0.64 *

/ could not be computed as the whole sample fell into the 'no awareness' category.
† $p=0.05$
* $p<0.05$
** $p<0.01$

mixed/grouped choice and clustering category (G= -1.00 p<.01). The majority of children selected the grouped arrangement and used extensive clustering at recall. This choice was also associated with an extensive awareness of how it aided recall (G= +0.64 p<.05). Finally, clustering category was negatively associated with awareness for the mixed display type (G= -0.51 p<.05), in that effective awareness was associated with limited or non-strategic ability.

Summary of Main Findings (Memory Task)

1: There was a significant increase in recall performance between each age group. The six-year-olds showed increased performance with the grouped display type, particularly if presented first.

2: The grouped display type led to greater clustering of items at recall, for all ages, and subsequently greater proportions of children in the extensively strategic category.

3: There was no difference in recall performance between the children in the three strategic categories.

4: There was a general developmental increase in the children's awareness of how categorical clustering aided recall.

5: The four-year-olds showed significant correlations between increased clustering and recall performance. The five-year-olds showed a developing ability to understand the effectiveness of categorical clustering in aiding recall performance. The six-year-olds showed how increased clustering was associated with selecting the grouped arrangement, and awareness of how this aided recall ability.

8.2.3 SELECTIVE ATTENTION TASK

8.2.3.1 SAME/DIFFERENT JUDGEMENTS

Total Number of Accurate Judgements

The total number of accurate judgements each child made across pairs was calculated. Due to unequal variances and a narrow range of scores, the number of accurate same/different judgements was divided by the total number possible i.e. four, and an arcsine transformation performed on this proportional score. Due to an unbalance design a three-way analysis of variance incorporating age, practice order and experimental order was not possible. A one-way between subjects ANOVA showed no effect of the two practice orders (i.e. same/different vs. different/same) ($F(1,58)=0.00$ $p>.05$). A two-way between subjects ANOVA showed no significant effect of the four experimental orders ($F(3,48)=0.45$ $p>.05$) but did reveal a significant main effect of age ($F(2,48)=10.15$ $p<.001$). Scheffe follow-up analysis revealed that the 4-year-olds produced significantly lower scores than the 6-year-olds (Scheffe $F(2,48)=120.56$ $p<.001$). The mean number of accurate judgements out of four, were 1.45, 2.30 and 2.95 for the 4-, 5- and 6-year-olds respectively. See Figure 8.11 for an illustration of this effect.

Age Differences

The number of children who responded either same or different for each house pair and each age group are shown in Table 8.19.

Pair 1 (same) Each age group generally had no difficulty in deciding that this pair of houses was the same. There were therefore no significant age differences (Fisher Exact Test ps>.05).

Pair 2 (one difference) Significantly more four-year-olds incorrectly stated that this pair of houses was the same, while the six-year-olds correctly stated that they were different ($X^2=4.90$ d.f.=1 $p<.05$). The five-year-olds were not significantly different to either the six- or the four-year-olds (X^2 ps>.05).

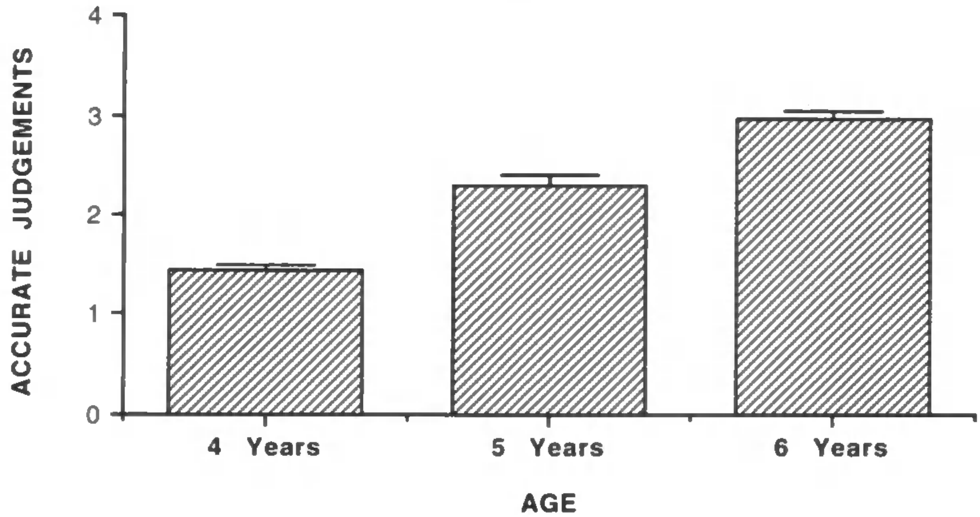
Pair 3 (two differences) Significantly more four-year-olds incorrectly stated that this pair of houses was the same, while both the five- and six-year-olds correctly stated that they were different ($X^2=3.84$ d.f.=1 $p<.05$ and $X^2=12.10$ d.f.=1 $p<.001$ respectively).

Pair 4 (different locations) Each age group generally had difficulty in deciding that this pair of houses was different. There were therefore no significant age differences (X^2 ps>.05).

TABLE 8.19 SAME/DIFFERENT JUDGEMENTS FOR EACH HOUSE PAIR

	PAIR 1		PAIR 2		PAIR 3		PAIR 4	
AGE	SAME	DIFF-ERENT	SAME	DIFF-ERENT	SAME	DIFF-ERENT	SAME	DIFF-ERENT
4	14	6	14	6	16	4	15	5
5	18	2	12	8	9	11	11	9
6	18	2	6	14	4	16	9	11
TOTAL	50	10	32	28	29	31	35	25

FIGURE 8.11 MAIN EFFECT OF AGE FOR THE TOTAL NUMBER OF ACCURATE JUDGEMENTS



Pair Differences

Comparison of performance across the four house pairs was analysed separately for each age group. For the four-year-olds a Cochran Q test for related samples showed there to be a significant difference between pairs ($Q=12.34$ d.f.=3 $p<.01$). McNemar test for significance of changes was used as a follow-up test to assess where the differences occurred, using the 0.025 significance level. This showed that performance on Pairs 1 and 3 neared significance ($X^2=5.06$ d.f.=1 $p<.05$). For the five-year-olds the Cochran test was also significant ($Q=12.20$ d.f.=3 $p<.01$), with the McNemar tests showing that performance on Pair 1 was greater than on both Pairs 2 and 4 ($X^2=6.75$ and 5.82 respectively, d.f.=1 $p<.01$). For the six-year-olds the Cochran test approached significance ($Q=7.46$ d.f.=3 $p>.05$). As can be seen from Table 28 their performance on Pair 4 deteriorated, in fact a post hoc Binomial test showed that performance on Pair 1 was greater than on Pair 4 (Binomial d.f.=1 $p<.025$).

Therefore Pair 1 seems to have been relatively easy, while Pair 4 was relatively difficult, for each age group. The 6-year-olds performed well on Pair 2 where there was one difference, while both the 5- and 6-years-olds performed well on Pair 3 where there were two differences.

8.2.3.2 WINDOW OPENING STRATEGIES

Table 8.20 details the number of children using the three different types of window opening strategies. See Appendix K and Section 8.1.5 for further details. In general for Pairs 1, 2 and 3, the 4-year-olds were either limited or non-strategic in their window opening, while the 5- and 6-year-olds were either limited or exhaustively strategic (Fisher Exact Test ps<.05). For Pair 4 the four-year-olds were again either limited or non-strategic, while the 5- and 6-year-olds were only limited in their strategy use (Fisher Exact Test ps<.05). Very few subjects were exhaustively strategic with this pair of houses.

8.2.3.3 TOTAL ACCURATE JUDGEMENTS AND OPENING STRATEGY

In order to compare the relationship between the child's total number of accurate

TABLE 8.20 WINDOW OPENING STRATEGIES

STRATEGY PAIR/AGE	EXHAUSTIVELY STRATEGIC	LIMITED STRATEGIC	NON-STRATEGIC
PAIR 1			
4 YEARS	0	16	4
5 YEARS	9	7	4
6 YEARS	8	10	2
TOTAL	17	33	10
PAIR 2			
4 YEARS	1	9	10
5 YEARS	12	6	2
6 YEARS	8	10	2
TOTAL	21	25	14
PAIR 3			
4 YEARS	0	10	10
5 YEARS	10	7	3
6 YEARS	10	7	3
TOTAL	20	24	16
PAIR 4			
4 YEARS	0	14	6
5 YEARS	4	13	3
6 YEARS	4	12	4
TOTAL	8	39	13

judgements and their window opening strategy, the strategy that each child used most predominantly across the four house pairs was assessed. If there was a tie between two strategies, the higher level strategy was recorded. A between subjects analysis of variance was performed on the total number of accurate judgements of similarity/ dissimilarity by the three strategic categories. Due to equal variances and a normal distribution no transformation was necessary. The factor of age could not be included in the analysis due to no four-year-olds being exhaustively strategic. The ANOVA showed a significant main effect of strategic category ($F(2,57)=8.19$ $p<0.01$). Scheffe follow-up analysis revealed that those children who used the exhaustive strategy were able to accurately judge the similarity of the house pairs more than the children who used the limited strategy ($p<.001$). There were no significant differences between the non-strategic category and both the limited and exhaustive categories, however subject numbers were low [mean accurate judgements = 2.00 (n=11), 1.78 (n=27) and 2.91 (n=22) respectively]. See Figure 8.12 for an illustration of this effect.

8.2.3.4 META-AWARENESS QUESTIONS

Table 8.21 details the number of children in each of the three awareness categories, which relate to the children's justifications of their same/difference response. See Appendix K and Section 8.1.5 for full details of these categories. In general the 4-year-olds showed no awareness of the necessity of comparing matching pictures across the house pairs, the 5-year-olds showed limited awareness of this ability and in Pair 3 even showed some extensive awareness. However it was the 6-year-olds who showed consistent extensive awareness across the four house pairs (Fisher Exact Test $ps<.05$).

8.2.3.5 ASSOCIATION BETWEEN MEASURES

The Gamma statistic was used to compare the relationship between the same/different judgements, the window opening strategies and the awareness categories. All these associations were assessed separately for the four house pairs and the three age groups. The results of these comparisons are detailed in Table 8.22. In general, for the four-year-olds the use of a limited opening strategy was related to a subsequent judgement that the houses were the same (correctly or incorrectly). For the five-year-olds an accurate

FIGURE 8.12 MAIN EFFECT OF STRATEGIC CATEGORY FOR THE TOTAL NUMBER OF ACCURATE JUDGEMENTS

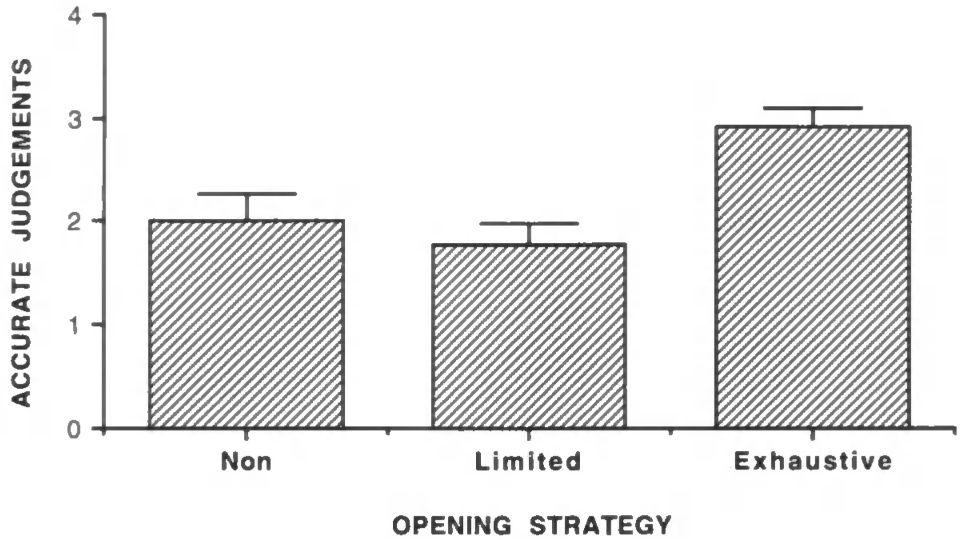


TABLE 8.21 META-AWARENESS CATEGORIES

CATEGORY PAIR/AGE	EXTENSIVE AWARENESS	LIMITED AWARENESS	NO AWARENESS
PAIR 1			
4 YEARS	4	3	13
5 YEARS	5	11	4
6 YEARS	12	3	5
TOTAL	21	17	22
PAIR 2			
4 YEARS	1		15
5 YEARS	4	7	9
6 YEARS	12	4	4
TOTAL	17	15	28
PAIR 3			
4 YEARS	1	4	15
5 YEARS	9	5	6
6 YEARS	14	3	3
TOTAL	24	12	24
PAIR 4			
4 YEARS	1	5	14
5 YEARS	10	7	3
6 YEARS	12	8	0
TOTAL	23	20	17

TABLE 8.22 GAMMA ASSOCIATIONS BETWEEN MEASURES

	4 YEARS		5 YEARS		6 YEARS	
MEASURE	S/D	Strategy	S/D	Strategy	S/D	Strategy
PAIR 1						
Strategy	+0.86 *		+0.20		+0.60 †	
Awareness	+1.00 **	+1.00 **	+0.74 *	+0.39	+1.00 **	+0.86 **
PAIR 2						
Strategy	-0.80 *		+0.54		+0.58 †	
Awareness	-0.18	+0.09	+0.72 *	+0.70 **	+0.92 **	+0.86 **
PAIR 3						
Strategy	-0.59		+0.33		+0.33	
Awareness	+0.14	+0.30	+1.00 **	+0.35	+0.81 **	+0.41
PAIR 4						
Strategy	-0.71 †		+0.70 *		-0.15	
Awareness	-1.00 **	+0.49	+0.12	+0.13	+0.80 *	+0.61 *

S/D Same/Different judgement.
† p=0.05
* p<0.05
** p<0.01

judgement was related to increased awareness, and for the six-year-olds these abilities were also related to the use of an exhaustive window opening strategy.

More specifically, the four-year-olds showed significant associations between all three measures for Pair 1. Accurately stated that this pair were the same was associated with using a limited opening strategy (G= +0.86 $p<.05$), and with all three awareness categories, while inaccurately stating they were different was associated with no awareness of the necessity of comparing homologous windows (G= +1.00 $p<.01$). This lack of awareness was also associated with being non-strategic (G= +1.00 $p<.01$). For Pairs 2 and 4, an inaccurate judgement was associated with limited strategy use, while for Pair 4 alone this inaccurate judgement was also associated with having no awareness of the necessity to compare windows across house pairs.

The five-year-olds showed a significant association between the same/different judgement and awareness categories for Pairs 1, 2 and 3 ($ps<.05$). The majority of children who made an accurate judgement showed either limited or extensive awareness of the basis of their decision, while the children who made an inaccurate judgement showed only limited or no awareness. For Pair 2, use of a limited opening strategy was associated with no awareness, while use of an exhaustive strategy was associated with limited or extensive awareness (G= +0.70 $p<.01$). Finally for Pair 4, inaccurately judging that this pair were the same was associated with a limited opening strategy, while stating they were different was associated with either a limited or an exhaustive window opening strategy (G= +0.70 $p<.05$).

For the six-year-olds the same/difference judgement was just significantly associated with strategy use for Pairs 1 and 2 (G= +0.60 +0.58 $ps=.05$). An accurate judgement followed the use of either a limited or an exhaustive window opening strategy. The same/different judgement was also positively associated with awareness categories for all four house pairs ($ps<.05$), in that the majority of children who gave accurate judgements were able to extensively justify why the house pairs were the same or different. This extensive awareness was associated with the use of either a limited or an exhaustive window opening strategy for Pairs 1, 2 and 4 (ps<.05).

Summary of Main Findings (Selective Attention Task)

1: More six-year-olds accurately assessed the similarity/dissimilarity of the house pairs than the four-year-olds.

2: The children had no difficulty in judging two identical houses, while changing the spatial location of the pictures caused difficulty. The five-year-olds were able to accurately judge a pair with two differences, while the six-year-olds were accurate when there was only one difference.

3: There was a general developmental increase in the use of exhaustive window opening strategies.

4: The use of the exhaustive strategy led to more accuracy in assessing the similarity/dissimilarity of the house pairs.

5: There was a general developmental increase in the children's awareness of the necessity to compare matching pictures across house pairs in order to justify their judgement.

6: The use of a limited window opening strategy in four-year-olds was associated with an accurate same/difference judgement for Pair 1 but an inaccurate judgement of Pairs 2 and 4. They were therefore better at judging similarity than dissimilarity, which was also illustrated by the association between stating a house was the same and extensive awareness of why this was the case. For Pair 1 this meant an accurate same/difference response and therefore a positive association between judgement and awareness, but for Pair 4 this meant an inaccurate response and a negative association between these two measures.

7: The five-year-olds showed strong associations between an accurate judgement and awareness of the basis of this judgement. For Pair 4, which required comparison between homologous windows while ignoring the fact that matching picture were in differing spatial locations, it was noted that those children that accurately stated this pair was different, were the ones using a more exhaustive opening strategy.

8: The majority of six-year-olds who gave an accurate judgement for a pair of houses were able to extensively justify that judgement by comparing homologous windows. This extensive awareness was generally associated with an exhaustive opening strategy.

8.2.4 TASK EFFECTS

In order to assess how the children's abilities compared across the three tasks, Spearman rank-order correlation coefficients were used to compare performance levels, and the Friedman two-way analysis of variance by ranks was used to compare strategic and awareness categories, separately for each age group.

8.2.4.1 PERFORMANCE

The children's drawing realism for both the cup and ball task, their recall score for the mixed and grouped display type, and their total same/difference score across the four house pairs, were correlated with each other. As can be seen from Table 8.23, the only significant correlation was for the six-year-old age group. Increased drawing realism on the cup task significantly related to increased recall ability for the mixed display type (r_s =0.54 n=20 p<.05). However it must be noted that these correlations could have been affected by narrow ranges of scores and low subject numbers. Figures 8.13, 8.14 and 8.15 illustrate more clearly the lack of relationship between measures for the four-, five- and six-year-olds respectively. They also show the odd subjects who seem to have contributed to these results, for example subjects 58, 41 (Figure 8.13), 3, 13 (Figure 8.14), 25 and 35 (Figure 8.15).

8.2.4.2 STRATEGIC ABILITIES

Friedman tests were used to assess whether children's strategic ability (non-strategic, limited strategic, extensively strategic) differed across the three tasks. Therefore for each age group, four tests were calculated between strategic attentional ability (ball and cup tasks), memory clustering ability (mixed and grouped display type) and the most predominant window opening strategy used across the four house pairs. The results of these are shown in Table 8.24.

There were no significant differences between tasks for the four-year-olds. The five-

TABLE 8.23 **CORRELATIONS FOR COMPARISON OF PERFORMANCE BETWEEN TASKS**

	Drawing Realism (Ball Task)	Drawing Realism (Cup Task)	Same/Difference Judgement
FOUR-YEAR-OLDS			
Recall (Mixed)	+0.32	-0.33	-0.11
Recall (Grouped)	+0.34	-0.33	-0.03
Same/Difference	-0.27	+0.05	
FIVE-YEAR-OLDS			
Recall (Mixed)	+0.16	-0.20	-0.12
Recall (Grouped)	+0.20	+0.22	+0.03
Same/Difference	-0.27	+0.24	
SIX-YEAR-OLDS			
Recall (Mixed)	+0.35	+0.54 *	+0.25
Recall (Grouped)	+0.20	+0.05	+0.08
Same/Difference	+0.33	+0.16	

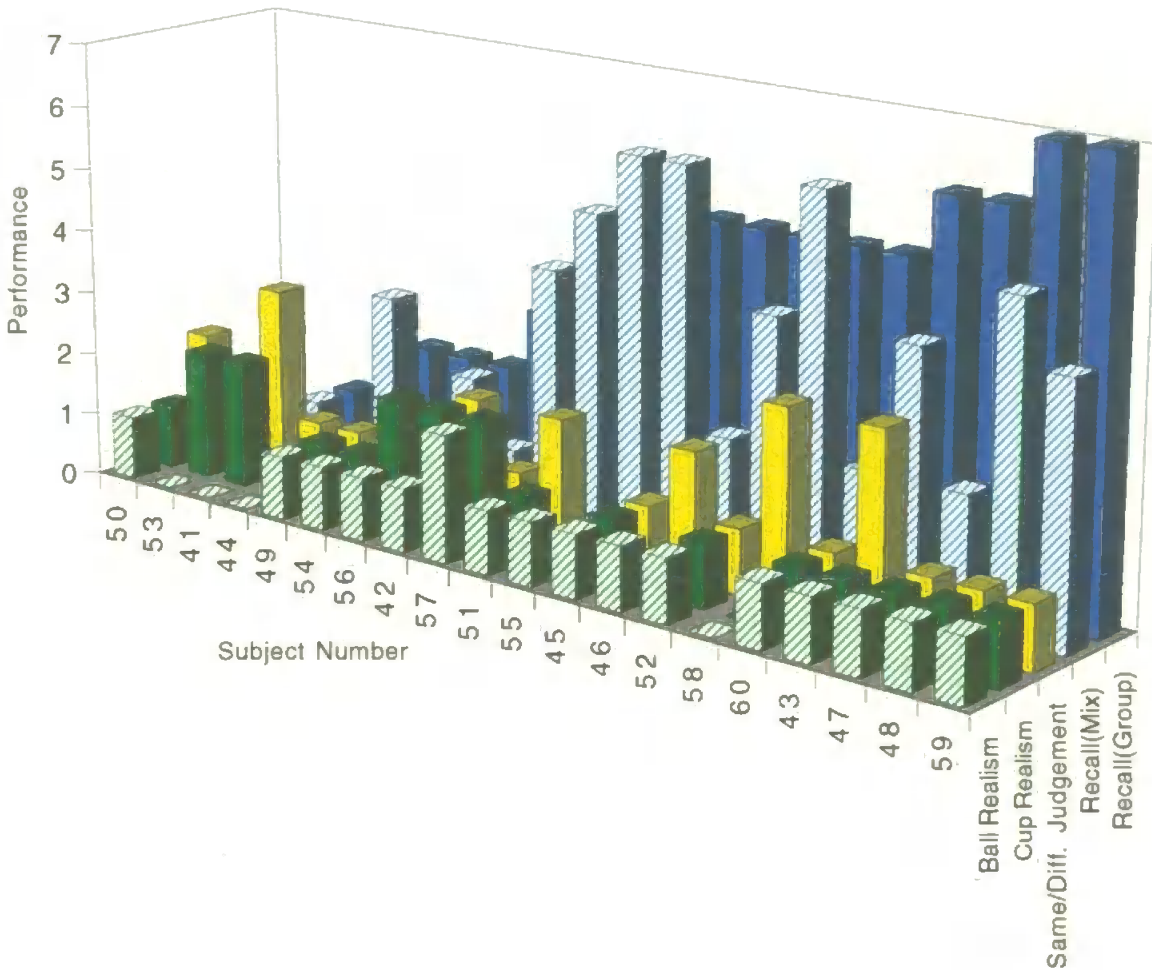
* $p<0.05$

TABLE 8.24 **FRIEDMAN TESTS FOR COMPARISON OF STRATEGIC ABILTITY BETWEEN TASKS**

TASK COMPARISONS †	SUM OF RANKS DRAW	MEM.	S.A.	F_r	D.F.	P.
FOUR-YEAR-OLDS						
Att.(ball) / Cluster(mixed) / WO	17.5	17.5	19.0	0.231	2	n.s.
Att.(ball) / Cluster(grouped) / WO	19.0	25.0	22.0	2.118	2	n.s.
Att.(cup) / Cluster(mixed) / WO	19.5	16.5	18.0	0.621	2	n.s.
Att.(cup) / Cluster(grouped) / WO	22.0	23.5	20.5	0.514	2	n.s.
FIVE-YEAR-OLDS						
Att.(ball) / Cluster(mixed) / WO	27.0	24.0*	39.0*	12.293	2	<0.01
Att.(ball) / Cluster(grouped) / WO	23.5	31.0	35.5	6.682	2	<0.05
Att.(cup) / Cluster(mixed) / WO	31.5	21.5*	37.0*	11.762	2	<0.01
Att.(cup) / Cluster(grouped) / WO	26.5	29.0	34.5	3.526	2	n.s.
SIX-YEAR-OLDS						
Att.(ball) / Cluster(mixed) / WO	37.0	35.0	48.0	7.538	2	<0.05
Att.(ball) / Cluster(grouped) / WO	32.0	46.5	41.5	8.346	2	<0.05
Att.(cup) / Cluster(mixed) / WO	34.5	36.0	49.5	12.133	2	<0.01
Att.(cup) / Cluster(grouped) / WO	29.0*	48.0*	43.0	14.109	2	<0.001

† Att.(ball) = Strategic attention for ball drawing task.
Att.(cup) = Strategic attention for cup drawing task.
Cluster(mixed) = Clustering strategy for mixed display type.
Cluster(grouped) = Clustering strategy for grouped display type.
WO = Window opening strategy for selective attention task.
* Significant differences at follow-up.

FIGURE 8.13 FOUR-YEAR-OLDS PERFORMANCE COMPARISON



NOTES:

The subjects are ranked in order of their recall performance on the memory task with the grouped display type [labelled 'Recall(Group)'].

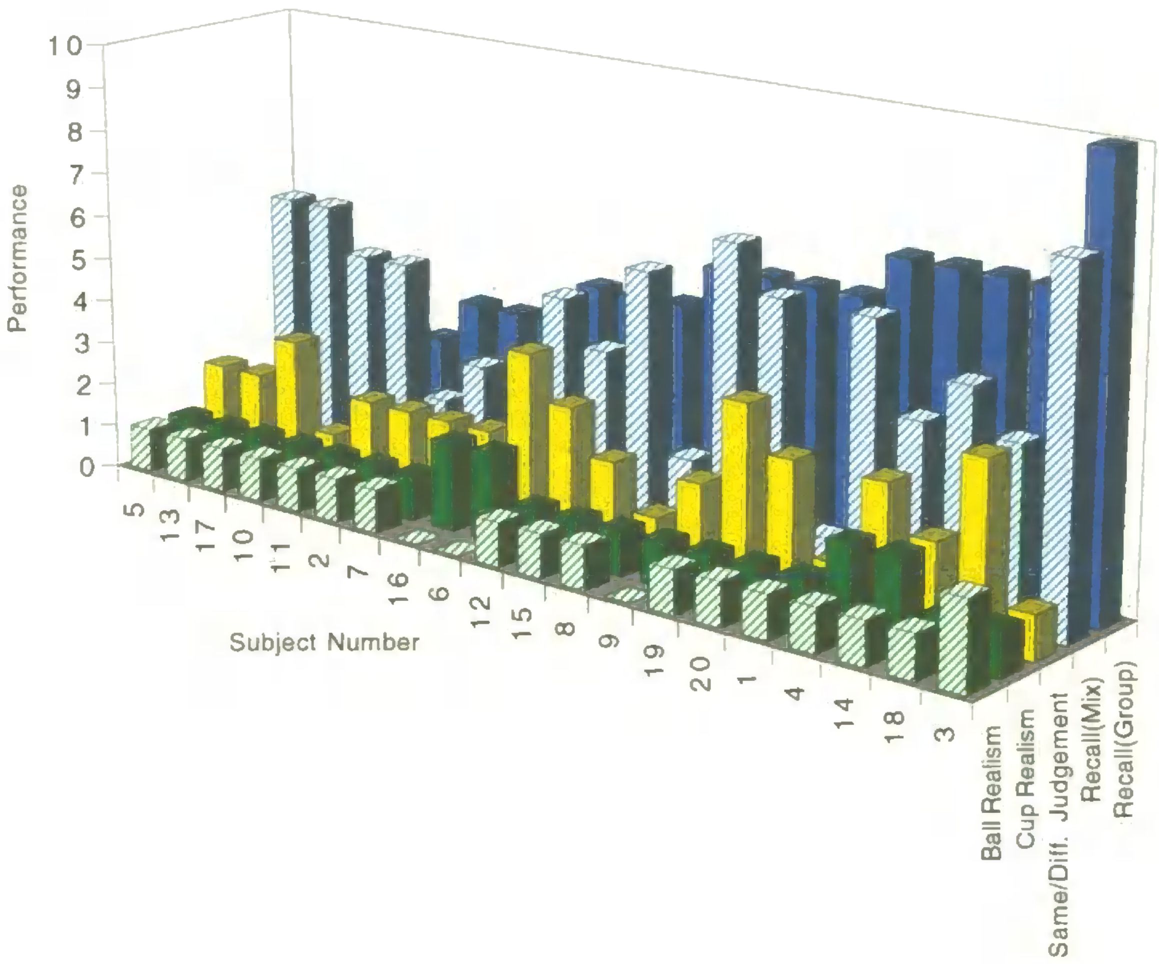
The scales are different for the three tasks.

For the drawing tasks (labelled 'Ball Realism' and 'Cup Realism') the children scored two if they visually realistic, one if they were intellectually realistic and zero if they were neither of these e.g. they scribbled.

For the selective attention task (labelled 'Same/Diff. Judgement') the childrens' scores ranged from zero to four correct judgements.

For the memory task [labelled 'Recall(Mix)' and 'Recall(Group)'] the childrens' scores ranged from zero to twelve cards recalled.

FIGURE 8.14 FIVE-YEAR-OLDS PERFORMANCE COMPARISON



NOTES:

The subjects are ranked in order of their recall performance on the memory task with the grouped display type [labelled 'Recall(Group)'].

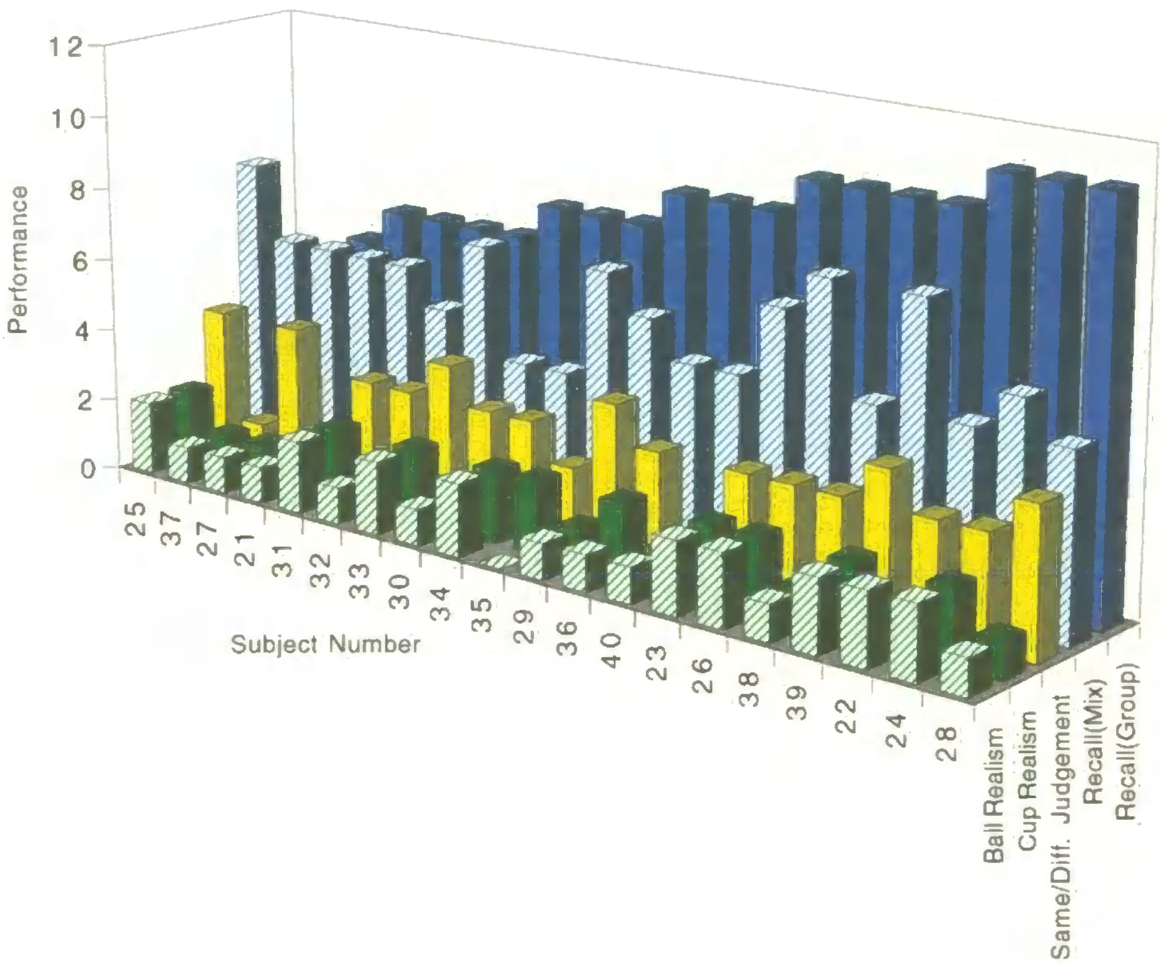
The scales are different for the three tasks.

For the drawing tasks (labelled 'Ball Realism' and 'Cup Realism') the children scored two if they visually realistic, one if they were intellectually realistic and zero if they were neither of these e.g. they scribbled.

For the selective attention task (labelled 'Same/Diff. Judgement') the childrens' scores ranged from zero to four correct judgements.

For the memory task [labelled 'Recall(Mix)' and 'Recall(Group)'] the childrens' scores ranged from zero to twelve cards recalled.

FIGURE 8.15 SIX-YEAR-OLDS PERFORMANCE COMPARISON



NOTES:

The subjects are ranked in order of their recall performance on the memory task with the grouped display type [labelled 'Recall(Group)'].

The scales are different for the three tasks.

For the drawing tasks (labelled 'Ball Realism' and 'Cup Realism') the children scored two if they visually realistic, one if they were intellectually realistic and zero if they were neither of these e.g. they scribbled.

For the selective attention task (labelled 'Same/Diff. Judgement') the childrens' scores ranged from zero to four correct judgements.

For the memory task [labelled 'Recall(Mix)' and 'Recall(Group)'] the childrens' scores ranged from zero to twelve cards recalled.

year-olds however showed significant differences for both the ball and the cup task compared to the mixed display type and their window opening strategy (F_r=12.29 and 11.76 d.f.=2 p<.01 respectively). Multiple comparisons between tasks revealed that for both of these, the five-year-olds strategic clustering ability on the memory task was significantly lower than their strategic window opening ability on the selective attention task. This age group also showed a significant difference between the ball task, the grouped display type and their window opening strategy (F_r=6.68 d.f.=2 p<.05), however multiple comparisons did not reveal any significant differences between the sums of ranks for the three tasks.

The six-year-olds showed significant differences for all four analyses (ps<.05), however follow-up only revealed a significant difference between sums of ranks for the cup task, grouped display type and selective attention comparison. The children's strategic attentional ability on the cup drawing task was significantly lower than their memory clustering ability when they were shown the grouped display type which prompted the child to use this strategy.

8.2.4.3 META-AWARENESS

Friedman tests were used to assess whether the children's meta-awareness (no awareness, limited awareness, extensive awareness) differed across the three tasks. Therefore for each age group, two tests were calculated between awareness of the attentional strategy in the drawing task (ball and cup), metamemory awareness and the most predominant awareness category shown across the four house pairs on the selective attention task. The results of these are shown in Table 8.25.

All comparisons were shown to be significant (ps<.05). For both the six- and the four-year-olds multiple comparisons between tasks revealed no significant differences between sums of ranks. Multiple comparisons for the five-year-olds however showed that, for comparisons with both the ball and the cup task, awareness of the mnemonic strategy of categorical clustering was less than their awareness of the necessity to compare homologous windows in order to justify their judgement on the selective

TABLE 8.25 FRIEDMAN TESTS FOR COMPARISON OF METACOGNITIVE AWARENESS BETWEEN TASKS

TASK COMPARISONS †	SUM OF RANKS DRAW	MEM.	S.A.	F_r	D.F.	P.
FOUR-YEAR-OLDS						
Drawing(ball) / Metamemory / SA	44.0	35.0	41.0	6.222	2	<0.05
Drawing(cup) / Metamemory / SA	45.0	34.5	40.5	7.400	2	<0.05
FIVE-YEAR-OLDS						
Drawing(ball) / Metamemory / SA	36.5	33.5*	50.0*	11.885	2	<0.01
Drawing(cup) / Metamemory / SA	37.5	33.0*	49.5*	10.582	2	<0.01
SIX-YEAR-OLDS						
Drawing(ball) / Metamemory / SA	34.5	37.5	48.0	8.553	2	<0.05
Drawing(cup) / Metamemory / SA	34.0	38.5	47.5	7.412	2	<0.05

† SA = Selective Attention task.
* Significant differences at follow-up.

attention task.

The lack of significant differences at follow-up for these analyses when the F_r statistics were significant, were possible due to the large number of tied ranks in the data. This was a result of the narrow range of scores (i.e. 1 to 3). The F_r statistic is increased by using the formula that corrects for ties, and the greater the number of ties the greater the increase in F_r. Therefore the inflated test statistics proved significant, but differences between the individual sums of ranks were not.

Summary of Main Findings (Task Effects)

1: Only the six-year-olds showed any comparable performance across the three tasks, in that increased drawing ability on the cup task correlated with increased recall for the mixed display type.

2: The five-year-olds showed an increased ability to use the exhaustive window opening strategies than they did to use the mnemonic strategy, when this was not prompted. The six-year-olds showed superior ability to use the mnemonic strategy when it was prompted, than they did to use an attentional strategy in the drawing task.

3: The five-year-olds showed increased awareness of the necessity to compare homologous windows in the selective attention task compared to their awareness of the mnemonic strategy of categorical clustering.

8.3 DISCUSSION

8.3.1 DRAWING TASK

The age related changes in drawing performance generally reflect those reported in previous chapters in that the six-year-olds performed significantly better than the younger age groups for the ball task, but showed no age differences on the cup task at this first stage of assessment. Overall levels of drawing ability were low with the majority of children being intellectually realistic on both tasks. Performance on the cup task was equivalent to Study 1 Task 1, where the significant age differences in levels of drawing realism occurred between six and eight years of age. The ball task did not seem to lead to any significant reduction in performance compared to the cup task, in fact compared to performance in Study 3 (Chapter 4), the six-year-olds seem to have performed relatively well, therefore leading to no lag in performance on this task. Chen & Holman (1989) reported increased difficulty with the ball task, but these differences occurred between seven and nine years of age. All three age groups in the present study were below these ages and therefore it is possible that task variations will only be revealed at later phases of assessment.

There were no corresponding age differences in the children's attention towards the drawing models. The six-year-olds did not attend to the model to any greater extent than the younger age groups. However in previous chapters, this age group tended to show increased attention only when they were instructed to do so, and not spontaneously. Therefore as only standard instructions were used in the present study the lack of age differences were quite consistent with the findings of the previous chapters.

Although there were no overall differences in attention towards the two drawing models, the cup model did seem to retain the childrens' interest when presented second, while the ball task produced a decrease in attention between being presented first and second. Previous chapters report how attention was consistently greater for the first task. However the same type of model had previously been presented within each study i.e. cups or balls, and therefore it is possible that the children first took time to assess the type of model *and* its specific arrangement. For subsequent models attention only needed to be paid to the change in arrangement and not to the actual model type. With the present study two different types of models were shown to the children, and although both showed reduced means when presented second, the effect was only significant for the cup/ball, and not for the ball/cup order. These two models are quite different in that the ball is a uniform shape which does not require extensive attention, while cups can vary quite considerably. It is therefore possible that when the cup was presented second the usual drop in attention occurred to a lesser extent because the child needed to assess not only the type of model but also its shape, in order to adequately draw it. This did not occur with the ball model because of the simplicity of its shape, and therefore a significant reduction in attention occurred.

The majority of attention occurred at the beginning of the task before drawing commenced. This was consistent with either a lack of strategic attention or possibly a limited strategy depending on the extent of attention paid. However it was noted that those children, at all ages, who did produce visually realistic drawings showed trends towards continually attending to the model while they drew. This was consistent with using the most extensive attentional strategy. As hypothesised there was a general developmental increase in strategy use between the three ages, particularly for the ball task. The four- and five-year-olds seem to have adopted a higher level of strategic attention of the cup task in that they were continually checking their drawing with the model in front of them. This was not so evident with the ball task and therefore reflects the argument discussed earlier that the simplicity of this task reduced levels of attention.

The older children in general were not any more strategically efficient than the younger children which reflects the lack of age differences in attentional ability, and is probably the result of the standard level of the instructions given. However the study aimed to assess spontaneous abilities and therefore the use of explicit instructions would have been inappropriate. Age differences might possibly be expected to develop over the next two phases of assessment. Similarly, although there were general increases in metacognitive awareness, overall levels of efficient awareness were relatively low.

With regard to the relationships among the three measure, i.e. drawing performance, strategy use and awareness, the four-year-olds showed associations between increased drawing realism and both increased strategy use and reduced awareness, for the cup task only. The former therefore reflects the results discussed earlier, in that even these young children were adapting to the demands of the particular task. They were attending to the model while they were drawing and were therefore classified as extensively strategic, this subsequently led to the production of a visually realistic drawing (60% of the visually realistic drawers used this strategy, and the remaining 40% used a limited strategy). However although this age group were being strategic they had very little awareness of their behaviour, in fact all of the visually realistic drawers fell into the 'no awareness' category. Although there is no previous research on metacognitive awareness of this particular strategic behaviour with which to compare these results to, they do seem to reflect those of other cognitive tasks.

The five-year-olds also showed this negative association between drawing realism and awareness for the cup task, but did show a positive association for the ball task. The majority of this age group (60% on the cup task and 70% on the ball task) were intellectually realistic and had either no or limited awareness of the effective attentional strategy. However for the cup task a further 15% were visually realistic and had no awareness, therefore resulting in the negative direction of this association. Therefore this age group showed increased levels of awareness compared to the four-year-olds, and although this related to performance levels, it did not relate to strategy use.

Th six-year-olds showed no relationships between their drawing performance and either strategy use or awareness of the strategies. They therefore showed quite diverse behaviour patterns across all levels of the three measures. They did however show how increased strategy use was related to increased awareness. Therefore unlike the five-year-olds, awareness did not relate to performance levels, but did relate to strategy use. Therefore they were showing increasing strategic abilities and awareness but these were not reflected in increased performance at this age. This result is therefore similar to the lag between using a selective attention strategy and benefiting from it (DeMarie-Deblow & Miller, 1988).

However the most consistent pattern of results revealed that particularly for the five- and six-year-olds, those few children who felt that they would not be able to draw the models, if they were hidden from view while they were actually drawing, were able to effectively justify this answer by referring to the necessity to attend to the model. Therefore these children showed extensive awareness of the attentional strategy. Although there were only a few subjects who stated "no" to the original metacognitive question, 100% of them gave this correct justification. It is expected that in later phases of assessment there will be an increase in the number of subjects performing at this level.

The results of the drawing task therefore showed corresponding increases in performance, strategy use and metacognitive awareness with age. Although overall levels were low, the childrens' abilities were affected by the specific task demands, i.e. the simplicity of the models and the standard instructions given. There is no previous research on the specific relationship between these measures however the patterns emerging seem to reflect those observed with other cognitive tasks. The four-year-olds showed a relationship between performance and strategy use, and although levels of these were low, the few children who were using more sophisticated attentional strategies, where also performing well on the drawing task. However at this age the children have no awareness of these strategies. This ability begins to develop around five years of age and showed an association with levels of drawing realism although not always in the predicted direction. It is therefore possible that these children were in a transitional phase in that some of the children in this age group drew well, and some of the children had some awareness of the attentional strategy, but these two abilities were not necessarily evident in the same individual. The six-year-olds, unlike the younger age groups, showed a relationship between increased strategy use and increased awareness of this, but these did not translate into increases in performance.

8.3.2 MEMORY TASK

There was a significant increase in memory recall performance between each of the three age groups, therefore confirming the hypothesis and previous research. The superior recall performance of the six-year-olds was the result of their ability to use the arrangement of cards at encoding to aid their subsequent recall behaviour. It was this age group alone who showed a significant increase in recall when they had studied the set of cards displayed in their conceptual categories. This grouped display type did however lead to an overall increase in the use of the clustering of items across all three ages. These results therefore reflect the findings of Baker-Ward, Ornstein & Holden (1984), in that the four-year-olds were attempting to use the mnemonic strategy but it was not until six years of age that this resulted in an increase in recall performance. Prompting the mnemonic strategy by showing the children the cards grouped together in their conceptual categories, led to the increased use of clustering at recall and therefore increased recall performance. This reflects how instructions in the drawing task can prompt a more sophisticated attentional strategy and increased drawing performance.

Dividing the children into three strategic categories based on their clustering scores showed that although there were no significant differences between the age groups and categories for the mixed display type, the grouped display type showed higher levels of extensively strategic behaviour, particularly for the six-year-olds. This is consistent with the analysis of the ARC scores in that their was a general lack of age differences and an increase in performance with the grouped display type. It also reflects the pattern of results for the recall scores in that it was the six-year-olds who benefited most from the prompt to use the categorical clustering strategy. However the analysis comparing the recall performance of the three groups of strategic behaviour did not reveal any differences, not even for the grouped display type.

Consistent with Schneider & Sodian (1988) the childrens' metacognitive awareness increased between four and six years of age. However although this study and Sodian *et al.* (1986) showed the four-year-olds to have some metacognitive awareness, in the present study all of the children in this age group showed no awareness of the clustering strategy.

However the metamemory task used was different to these previous studies and also seemed to cause confusion for these young children. The five-year-olds showed a move towards limited awareness, however it was the six-year-olds who showed extensive awareness of how categorical clustering of items at encoding can aid recall ability. This therefore agrees with previous research in this respect.

Only the four-year-olds showed a significant correlation between recall performance and their clustering strategy and then only for the grouped arrangement. Therefore the general lack of relationship between these two measures reflects the lack of difference between the strategic categories with regard to their recall scores as discussed earlier. These results are consistent with Henry & Norman (in press) who found that recall performance was related to strategy use in four- to five-year-olds, however they did not study older children therefore it is unknown whether this relationship would still remain evident with age. Sodian, Schneider & Perlmutter (1986) assessed four- and six-year-old age groups but found the opposite to the present study, in that although there was no relationship between performance and conceptual clustering at recall for the four-year-olds, the six-year-olds did show such a relationship. Although both their study and the present study measured clustering ability, Sodian *et al.* allowed the children to organise toys themselves while the present study presented cards either clustered or randomly arranged. The two studies also differed in respect of the clustering measure used.

The grouped display type led to increased recall and increased clustering for the six-year-olds yet the two were not correlated with each other. However correlational analysis can be problematic particularly when subject numbers are low (n=20), and where one of the variables only has three possible values with 70% of the age group falling into just one of these i.e. extensively strategic, and only one subject falling into the non-strategic category, with this subject performing relatively well. The four-year-olds however had even greater problems due to the fact 45% of them could not be classified into any strategic category as their ARC scores were undefined. This resulted in the correlation being performed on the scores from only eleven subjects. Despite this there was a significant correlation between recall and clustering category. Therefore, like the drawing task, even though this age group as a whole showed low levels of recall and low levels of strategic ability, those few subjects that were using the strategy when they were prompted to do so, were benefiting from it.

There were no significant relationships between recall performance and metacognitive awareness for the five- and six-year-olds (this could not be assessed for the four-year-olds due to the whole sample showing no awareness). This was again inconsistent with previous research. Sodian *et al.* found that the six-year-olds showed a significant relationship between these measures, while the four-year-olds did not. Schneider & Sodian (1988) reported relationships for both four- and six-year-olds, and Henry & Norman (in press) reported the same in four- to five-year-olds. However metacognitive assessment is problematic particularly with younger children, and most of these studies tackled the problem in different ways. Henry & Norman criticised the use of verbal tasks as it is possible that young children have no conscious awareness of their behaviour or are unable to verbalise the basis of it. They therefore performed a non-verbal task and concluded that four- and five-year-old children did have awareness that the other studies had failed to assess. In the present study the children did have the opportunity to just point to which arrangement they felt would help them remember the cards more (although this measure did not correlate with recall), however they were then asked to give a verbal reason why they had made this choice. Therefore the lack of relationship could be due to difficulty in assessing awareness, and it is possible that differences could develop later in the study.

The five- and six-year-olds showed significant negative associations between strategy use and awareness but only for the mixed display type, therefore increased awareness of how the strategy would help them remember the cards related to reduced clustering at recall. However the mixed display type did not provide any prompt to the mnemonic strategy of categorical clustering, and therefore assessed the ability to internally reorganise the cards into their categories. With these young children it was not surprising that clustering ability was relatively low for this task, in comparison to the grouped display type that did prompt the strategy. Coupled with the increase in awareness of how clustering can aid recall at these ages the association between these two measures was therefore in a negative direction.

The results of the memory task show that recall performance, strategy use and metacognitive awareness increased with age and with the display type. Prompting the children to use the strategy of clustering the items, increased strategy use and recall performance, particularly for the six-year-olds. Consistent with the drawing task, the few four-year-olds who did use the clustering strategy recalled more items, although the four-year-old age group as a whole showed low levels of performance and strategy use. When the five- and six-year-olds were not prompted to use the strategy their performance decreased in relation to their increased awareness of the strategy.

8.3.3 SELECTIVE ATTENTION TASK

The childrens' overall performance on the selective attention task reflected performance on the other tasks, in that more six-year-olds showed greater accuracy in differentiating the house pairs, than the younger children. With regard to the separate house pairs, even the four-year-olds were able to make an accurate judgement when the houses were the same, the five-year-olds could accurately judge dissimilarity when there were two differences, however it was not until six years of age that the children could accurately judge a pair of houses with only one difference. Therefore increased dissimilarity appears to be necessary before the younger children can accurately judge the pairs of house. Changing the spatial locations of the pictures confused even the six-year-olds. However the children had no previous exposure to this type of house pair because the two practice pairs consisted of a same pair and a pair with two differences. However a child that has understood the necessity of comparing homologous windows should realise that this particular pair is in fact dissimilar. It is possible that as yet these children do not have this understanding, and that it will develop over subsequent testing phases.

These results therefore reflect those found by Vurpillot (1968). He also found that the younger children were better at judging similarity and that performance increased with the number of differences between the two houses. Vurpillot reported that 90% of the four- and five-year-olds accurately assessed the similar houses and only 25% correctly assessed house pairs that contained one difference. In the present study these percentages were very similar i.e. 80% and 35% respectively.

The majority of children (84%) opened all the windows. Therefore the children did not terminate their search once a difference had been found, as observed by Vurpillot. However his subject groups were older than in the present study, and therefore it is possible that this behaviour may develop in later phases. There was also the fact that the tasks varied in that all the pictures were visible to begin with in Vurpillot's study, whereas they were hidden behind 'shutters' in the present study. The latter task also resembled several childrens' games and therefore it is possible that they were familiar with, or interested in opening all the windows. Miller & Weiss (1981) also observed how children up to the age of seven generally opened all the doors in order to inspect the pictures underneath.

Although they may not terminate their search in the way Vurpillot described, strategic search behaviour did increase with age, with the four- and five-year-olds being either non-strategic or limited in their strategy use, and the six-year-olds being either limited or extensively strategic. Twenty-eight percent of subjects were extensively strategic, 50% were limited and 22% were non-strategic. The majority of the extensive group (85%) opened homologous windows while the remaining 15% opened all the windows in one house, then all the windows in the second, but scanned back to the homologous picture pair as they did so (doing this without scanning back accounted for the majority of children in the limited strategy group). The children that did use these exhaustive strategies were subsequently more accurate in differentiating the house pairs.

These results therefore agree with Vurpillot in that systematic search behaviour is evident at six years of age, but also showed that in agreement with Day & Bissell (1978), it is also evident to some extent in four- and five-year-olds. Although only one four-year-old was classified as exhaustively strategic, a large proportion of this age group were using limited strategies and therefore could not be classified an non-systematic. The five-year-olds were showing equivalent levels of exhaustive strategic search behaviour to the six-year-olds.

The children were classified into three categories of metacognitive awareness on the basis of their justifications of why they thought the house pairs were the same or different. The four-year-olds did not seem to have any awareness of the necessity to compare the matching pictures across the pair of houses and tended to, for example, just point to one window or the house(s) as a whole. The five-year-olds however showed some limited awareness and even showed extensive awareness with Pair 3. This was the pair that had two differences, for which this age group performed relatively well. Therefore it seems that the increase in the number of differences not only aided their accuracy at differentiating the houses, but also their ability to justify their judgement. However it was the six-year-olds who showed consistent extensive awareness across the four house pairs.

Day & Bissell (1978) found that four-year-olds tended to make their justifications using a definite criteria that was not necessarily the same as the criteria used by older children or adults. For example, they based their decisions on the similarity/dissimilarity of one pair of windows and not all six. This would be consistent with a limited awareness category in the present study, but very few four-year-olds (20%) showed this level of awareness. However Day & Bissell's subjects ranged from 4 years 2 months to 4 years 11 months and therefore the older children were similar in age to the present study's five-year-olds (mean 5 years 1 month). This age group in the present study did show a higher level of limited awareness (38%).

As discussed earlier the four-year-olds were more able to accurately judge a house pair if they were the same. This was further demonstrated by an accurate same/different judgement being associated with a limited opening strategy for Pair 1, but this strategy also being associated with an inaccurate judgement for Pairs 2 and 4. Pair 1 was the same, Pair 2 had only one difference and Pair 4 had the same pictures in different spatial locations. Use of a limited opening strategy generally involved opening one house then the other without scanning back, or searching for picture pairs. This meant that it was easy to miss the one difference in Pair 2 or to get confused with regard to the necessity of the matching pictures to be in the same spatial locations across the two houses in Pair 4. Therefore this limited strategy was sufficient enough if the houses were the same, but not if they were different. This was further illustrated by the association between judging a house pair as the same and extensive awareness of why this was the case. For Pair 1 this meant an accurate same/difference judgement and therefore a positive association between judgement and awareness, but for Pair 4 this meant an inaccurate judgement and a negative association between these two measures. The five-year-olds were also generally unable to accurately judge that Pair 4 were different, however those few children who were able to do so correctly, were the ones using the more exhaustive window opening strategies. Therefore increased strategic ability at this age aided their ability to effectively differentiate this particular pair of houses.

With age the children became more capable of justifying their judgements. The five-year-olds showed associations between judgement and awareness, however the six-year-olds also showed how this extensive awareness was associated with exhaustive strategic ability. In agreement with Day & Bissell (1978), even the four- and five-year-olds had some awareness of why the house pairs were the same or different in that they could systematically compare the two houses.

The results of the selective attention task therefore agree with the other two tasks in that the six-year-olds showed increased accuracy in differentiating the house pairs, although these performance levels were affected by the specific demands of the four house pairs. Similarly strategy use and metacognitive awareness also increased with age, with comparisons between these three measures becoming increasing associated with age.

8.3.4 TASK EFFECTS

Comparison of performance within each of the three tasks showed fairly similar results, in that the six-year-olds were out performing the younger age groups, but that this overall pattern was affected by specific task demands, for example the differences between the ball and cup models, the mixed and the grouped display type, and the varying demands of the four house pairs. Direct comparison between the tasks themselves revealed that the childrens' performance levels were not comparable, except for the six-year-olds who showed that increased drawing realism on the cup task was related to increased recall ability when they were presented with the mixed display type. This age group showed consistent patterns of results for the ball and cup task, and although as a group it would seem possible that if the cup task correlated with memory performance then so should the ball task, as individuals this was obviously not the case. There were in fact only two subjects (Subjects 35 and 36) who performed differently on the two drawing tasks and Subject 35 in particular produced a visually realistic drawing of the cup but an omission drawing of the ball. Coupled with the fact that this subject performed relatively well on the memory task (mixed display type), it seems that this has led to the lack of correlation between this and drawing ability on the ball task (see Figure 8.15).

Unlike performance levels, strategic abilities seem to be fairly consistent across the tasks except where the children were affected by the task demands. In particular the five- and six-year-olds were affected by the display type presented to them in the memory task. Prompting them to the mnemonic strategy led to increases in strategic ability, while not providing this prompt and relying on either spontaneous ability or the ability to transfer the strategy used on the grouped display type (depending on the order of presentation of the tasks) led to reductions in strategic ability in relation to the other tasks. For the six-year-olds this was in relation to their attentional ability on the cup drawing task. This age group has been shown to increase their strategy use in response to instructions that prompt them to do so. However in the present study they were only presented with standard instructions and therefore did not show high levels of strategic ability. The grouped memory task did however prompt the appropriate strategy and therefore led to higher levels of strategic ability.

Despite the lack of strong differences across tasks within each of the age groups, there was a general increase in strategic abilities between ages. Metacognitive awareness was similarly consistent across the tasks, except again where the increased demands of the metamemory task led to reduced awareness compared to the selective attention task, for the five-year-olds at least. However unlike for the strategic abilities, there were relatively few differences between the age groups with regard to general levels of awareness.

Therefore the evidence seems to support the view that children develop a general strategic ability or understanding that filters through to all tasks, and therefore that strategic development is not sequential across various cognitive abilities. That is, children do not develop strategic behaviour at different times for different tasks. However this general ability was affected by the demands of the task, for these younger age groups at least. For the four-year-olds the demands are high and therefore strategic ability is consistently low, while the five- and six-year-olds will respond to prompts regarding the use of more sophisticated strategies.

The children were however performing differently on the three tasks and therefore despite consistent strategic abilities these do not generally translate into consistent performance levels within the individual. It is possible that this disparity is due to lack of experience or knowledge of the particular tasks. To begin with the use of efficient strategies can lead to a lack of processing capacity to devote to actual performance, however as they become more practised and familiar then strategy use becomes more automated and benefits in performance develop (DeMarie-Deblow & Miller, 1988). This would therefore be consistent with the fact that the only significant correlation between performance levels was found with the older age group. Therefore, although strategy use is a prerequisite it does not necessarily lead to an initial increase in performance. Assessment of the awareness levels also showed fairly consistent patterns across tasks although this did not show the increase in ability with age. Consistent with previous research even the younger children showed some awareness of efficient strategies in different tasks, but again this does not initially translate into the use of these strategies or increases in performance levels.

8.3.5 CONCLUSIONS

The results of this phase of assessment demonstrate that the relationship between strategic attention to a model and drawing performance, which has not been documented in previous literature, reflects the development of other cognitive tasks that have been more widely assessed. It is hypothesised that the later phases will show corresponding increases in these strategic abilities and increasing associations between these measures.

CHAPTER 9

LONGITUDINAL STUDY PHASE 2

9.1 METHOD

9.1.2 SUBJECTS

Out of the original sixty children, forty-seven were available at the second phase of assessment. There were fourteen children in the youngest age group which had a mean age of 4 years 6 months (range 4:3 to 4:9, standard deviation 0:2 months). The middle age group consisted of eighteen children with a mean age of 5 years 8 months (range 5:4 to 5:10, standard deviation 0:2 months), and the oldest age group had fifteen children remaining with a mean age of 7 years 5 months (range 7:2 to 7:8, standard deviation 0:2 months). These age groups will subsequently be referred to as four-, five- and seven-year-olds. There were twenty-four males and twenty-three females in total. There were eight males and six females in the four-year-old age group, nine males and nine females in the five-year-old age group, and seven males and eight females in the seven-year-old age group.

9.1.3 ATTRITION

Between the two assessment phases a school year ended and therefore several children changed schools. However the majority of the children that left, did so because their families moved. The school is situated close to a Naval base and therefore it is quite common for the families to be moved away. In order to determine whether the children who were not available for testing at the second phase were significantly different from the children who remained, their performance at Phase 1 was compared.

Drawing Task

There were a disproportionate number of visually realistic five-year-olds on the cup drawing who were unavailable at Phase 2 (Fisher Exact Test $p<.05$), although there were no differences for the ball drawing. There were only four visually realistic drawers for the cup task in this age group, and two of these had left the school by Phase 2, compared to all sixteen of the intellectually realistic drawers being available. Although the Fisher's test was insignificant for the seven-year-old age group, it must be noted that four out of the six children who produced intellectually realistic drawings of ball and cup tasks at Phase 1, were unavailable at Phase 2. Only one visually realistic child was unavailable, compared to eight for the ball task and nine for the cup task, who were available.

There were no significant differences between the two subject groups with regard to either their number of looks or looking time ($F(1,54)=1.90$ and 1.24 $ps>.05$ respectively). There were also no significant interactions between attrition and age ($F(2,54)=1.08$ and 0.53 $ps>.05$ respectively). With regard to the classification of the children's attention into strategic categories, there were disproportionately more five- and six-year-olds classified as non-strategic on the ball task who were unavailable at Phase 2 (Fisher Exact Test $ps<.01$). There were no significant differences regarding classification of strategic behaviour on the cup task. There were no significant differences regarding classification of awareness of the attentional strategy, for both tasks and all three age groups (Fisher Exact Test $ps>.05$).

Memory Task

There were no significant differences between the two subject groups with regard to either their memory recall scores or their ARC clustering scores ($F(1,54)=0.01$ and 0.35 $ps>.05$ respectively), or any interactions between attrition and age ($F(2,54)=0.18$ and 0.63 $ps>.05$ respectively). There were no significant differences regarding classification of strategic behaviour or awareness of the clustering strategy, for either the grouped or the mixed display type, for each of the age groups (Fisher Exact Test $ps>.05$).

Selective Attention Task

There was no significant difference between the two subject groups with regard to their total number of accurate same/different judgements across house pairs ($F(1,54)=0.11$ $p>.05$), however there was a significant interaction between attrition and age ($F(2,54)=$

5.17 $p<.01$). Follow-up analysis revealed that for the group of subjects who were available at Phase 2, the four-year-olds were less accurate than the six-year-olds, while there were no differences between the ages for the subjects who were not available. However subject numbers for this latter group were low.

There were no significant differences regarding classification of the most predominant window opening strategy, or classification of the most predominant awareness category across house pairs, for each of the age groups (Fisher Exact Test $ps>.05$).

Although in general there were few differences in performance at Phase 1, between the subjects who were available at Phase 2 and those who were not, the disproportionate loss of children producing the two types of drawings was problematic. It seems that there were a disproportionately high number of intellectually realistic five-year-olds and visually realistic seven-year-olds at Phase 2.

The remaining sections i.e. Design, Materials, Procedure, Scoring, and Statistical Analysis were identical to Phase 1.

9.2 RESULTS

The following sections detail the main findings of the analyses. The full analysis of variance summary tables and details of the subsidiary results are given in Appendix M.

9.2.1 DRAWING TASK

9.2.1.1 DRAWING DATA

The number of children in each age group producing the different categories of drawings in response to the two models are detailed in Table 9.1.

Cup Drawing

Chi-Square tests showed that a greater proportion of seven-year-olds produced visually realistic drawings than both the four- and five-year-olds ($ps<.01$), with the latter two age groups not being significantly different from each other (Fisher Exact Test $p>.05$). Therefore the seven-year-olds showed an improvement in performance in comparison to Phase 1.

Ball Drawing

Chi-Square and Fisher Exact Probability tests showed that, like the cup drawings, a greater proportion of seven-year-olds produced visually realistic drawings than both the four- and five-year-olds ($ps<.05$), with the latter two age groups again not being significantly different from each other (Fisher Exact Test $p>.05$). The results for this task were therefore equivalent to performance at Phase 1.

Comparison Across Tasks

A Phi correlation coefficient was calculated in order to compare the relationship between a child being classified as either intellectually or visually realistic on each of the two tasks. This correlation was significant ($r_ø=0.45$ d.f.$=44$ $p<.01$), in that most children showed comparable performance i.e. they were generally intellectually realistic on both tasks. Fisher tests also confirmed this pattern of results overall combining all ages

TABLE 9.1 FREQUENCY OF DRAWINGS FOR EACH MODEL

	CUP DRAWING			BALL DRAWING			
Age	Visually Realistic	Intellec-tually Realistic	Scr-ibble	Visually Realistic	Intellec-tually Realistic	Omis-sion	Scr-ibble
4	3	11	0	1	12	1	0
5	1	17	0	3	15	0	0
7	12	3	0	9	6	0	0

($p<.01$). See Table 9.2 for further details of this effect. Fisher tests for the individual ages revealed that the 4- and 5-year-olds showed no significant differences across tasks ($p>.05$). Inspection of the data in Table 9.2 shows that most of these children were intellectually realistic on both tasks. For the 7-year-olds, significantly more children were visually realistic on both tasks (Fisher Exact Test $p<.05$). Therefore this age group improved in drawing performance in comparison to Phase 1.

9.2.1.2 ATTENTIONAL DATA

9.2.1.2.1 Number of Looks

A 3 (age) x 2 (gender) x 2 (drawing order) x 2 (drawing model) x 4 (look type) analysis of variance was performed on the number of times each child looked at the model in front of them. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

Unlike Phase 1, the ANOVA showed a significant main effect of age ($F(2,35)=8.55$ $p<.01$). Scheffe's method of follow-up analysis revealed that the seven-year-olds looked at the model more times than the four- and five-year-olds (Scheffe $ps<.01$). See Table 9.3 for details of these means. There were no significant main effects of drawing order or drawing model ($ps>0.05$), however age significantly interacted with these factors. Follow-up analysis of the age by drawing order interaction ($F(2,35)=3.41$ $p<.05$) revealed that the above detailed age effect was only evident with the cup/ball order. Follow-up analysis on the age by drawing model interaction ($F(2,35)=4.04$ $p<.05$) revealed that the age effect was only evident with the cup model. The seven-year-olds were therefore looking more than the other age groups at the cup model, particularly if this was presented first. See Table 9.3 for details of the means.

The ANOVA showed a highly significant main effect of look type ($F(3,100)=215.35$ $p<.001$*). Follow-up analysis revealed that significantly more looks occurred at the 'beginning' of the task compared to all other look types (Scheffe $ps<.001$), and the 'within' looks were significantly greater than the 'between' looks (Scheffe $F(3,100)=9.45$

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 9.2 COMPARISON OF PERFORMANCE ACROSS DRAWING TASKS

	BALL VISUAL REALISM (V.R.)		BALL INTELLECTUAL REALISM (I.R.)	
AGE	CUP V.R.	CUP I.R.	CUP V.R.	CUP I.R.
4	0	1	3	9
5	0	3	1	14
7	9	0	3	3
TOTAL	9	4	7	26

TABLE 9.3 MEAN NUMBER OF LOOKS PER AGE BY DRAWING ORDER, AND AGE BY DRAWING MODEL

ORDER	4 YEARS	N	5 YEARS	N	7 YEARS	N
BALL/CUP	0.12 (0.46)	7	0.13 (0.45)	8	0.15 (0.63)	7
CUP/BALL	0.11 (0.46)	7	0.10 (0.36)	10	0.22 (0.89)	8
MODEL						
BALL	0.13 (0.54)	14	0.10 (0.40)	18	0.17 (0.64)	15
CUP	0.10 (0.39)	14	0.11 (0.42)	18	0.21 (0.87)	15
MEAN TOTAL	**0.12 (0.46)**		**0.11 (0.41)**		**0.19 (0.76)**	

Untransformed means (number of looks) are shown in parentheses.

p<.05*). The mean number of looks were 1.57, 0.09, 0.34 and 0.17 for the 'beginning', 'between', 'within' and 'end' look types respectively. Look type significantly interacted with age ($F(6,100)=4.77$ $p<.001$*) to show that only the seven-year-olds looked more 'within' than 'between'. Age and look type also interacted with drawing order ($F(6,100)=3.42$ $p<.01$*) which revealed that the seven-year-olds only showed an increase in their 'within' looking with the cup/ball order. See Table 9.4 and Figure 9.1 for further details of this effect.

The ANOVA showed interactions between look type and drawing model ($F(3,93)=6.93$ $p<.001$*) and between look type, drawing model and age ($F(5,93)=6.08$ $p<.001$*). Follow-up analysis revealed that the 'within' looks were significantly greater than the 'between' looks for the cup model only, and that this effect was produced by the seven-year-olds alone (Scheffe ps<.01). See Table 9.5 for details of the means and Figure 9.2.

The variations in the number of looks the children made towards the drawing models where therefore produced by the seven-year-olds increasing their looking 'within' drawing separate elements of the model. This pattern of behaviour was particularly evident with the cup model and with the cup/ball order i.e. where the cup was presented to the child first. No such variations in attention were evident in Phase 1 therefore the older age group have progressed to a more beneficial attentional strategy over the six months between assessments.

Number of Looks and Drawing Realism

Two, 3 (age) x 2 (drawing realism) analyses of variance, one for each model, were performed in order to compare the number of looks of the visually and intellectually realistic drawers. Due to unequal variances and the standard deviations being proportional to the means, log(10) transformations were performed on the data.

For the cup model, the ANOVA showed significant main effects of drawing realism ($F(1,41)=11.89$ $p<.01$) and age ($F(2,41)=7.65$ $p<.01$), and an interaction between these

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 9.4 MEAN NUMBER OF LOOKS PER LOOK TYPE, AGE AND DRAWING ORDER

AGE	DRAWING ORDER	BEGINNING	BETWEEN	WITHIN	END
4 YEARS	BALL/CUP	0.39 (1.50)	0.04 (0.14)	0.02 (0.07)	0.04 (0.14)
	CUP/BALL	0.43 (1.79)	0.02 (0.07)	0.00 (0.00)	0.00 (0.00)
MEAN TOTAL		**0.41 (1.64)**	**0.03 (0.11)**	**0.01 (0.04)**	**0.02 (0.07)**
5 YEARS	BALL/CUP	0.36 (1.38)	0.00 (0.00)	0.06 (0.19)	0.07 (0.25)
	CUP/BALL	0.36 (1.35)	0.02 (0.05)	0.00 (0.00)	0.01 (0.05)
MEAN TOTAL		**0.36 (1.36)**	**0.01 (0.03)**	**0.02 (0.09)**	**0.04 (0.15)**
7 YEARS	BALL/CUP	0.40 (1.64)	0.05 (0.14)	0.09 (0.43)	0.08 (0.29)
	CUP/BALL	0.42 (1.75)	0.04 (0.13)	0.31 (1.38)	0.09 (0.43)
MEAN TOTAL		**0.41 (1.70)**	**0.04 (0.14)**	**0.21 (0.90)**	**0.09 (0.30)**

Untransformed means (number of looks) are shown in parentheses.

TABLE 9.5 MEAN NUMBER OF LOOKS PER LOOK TYPE, AGE AND DRAWING MODEL

DRAWING MODEL	AGE	BEGINNING	BETWEEN	WITHIN	END
BALL	4 YEARS	0.43 (1.79)	0.04 (0.14)	0.02 (0.07)	0.03 (0.14)
	5 YEARS	0.36 (1.41)	0.02 (0.05)	0.02 (0.06)	0.02 (0.06)
	7 YEARS	0.42 (1.72)	0.08 (0.27)	0.07 (0.25)	0.10 (0.33)
MEAN TOTAL		**0.40 (1.64)**	**0.04 (0.15)**	**0.04 (0.13)**	**0.05 (0.18)**
CUP	4 YEARS	0.38 (1.50)	0.02 (0.07)	0.00 (0.00)	0.00 (0.00)
	5 YEARS	0.36 (1.31)	0.00 (0.00)	0.03 (0.13)	0.06 (0.24)
	7 YEARS	0.41 (1.67)	0.00 (0.00)	0.35 (1.55)	0.08 (0.27)
MEAN TOTAL		**0.38 (1.49)**	**0.01 (0.02)**	**0.12 (0.56)**	**0.05 (0.17)**

Untransformed means (number of looks) are shown in parentheses.

FIGURE 9.1 INTERACTION OF AGE BY DRAWING ORDER BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE

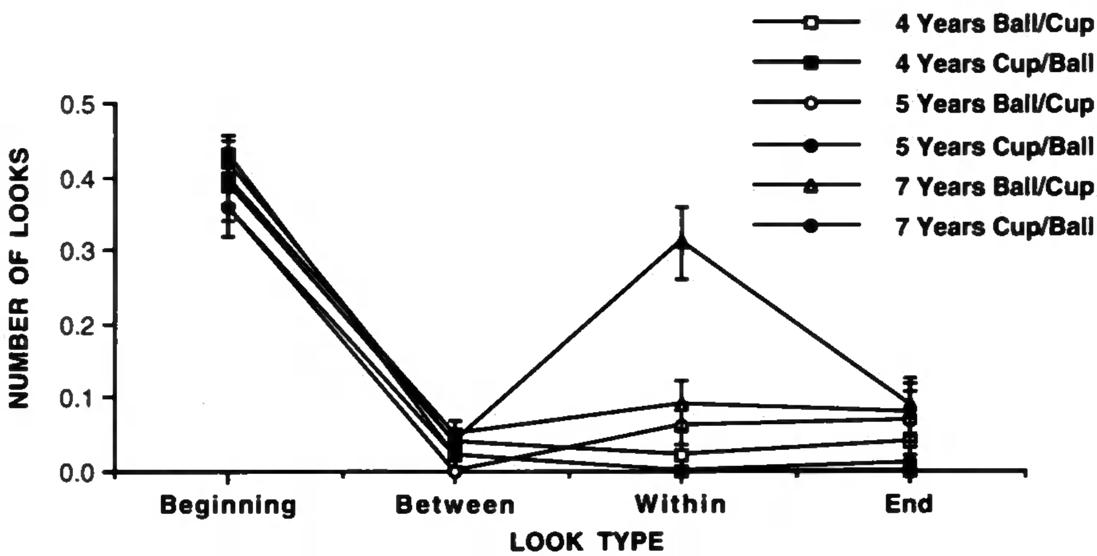
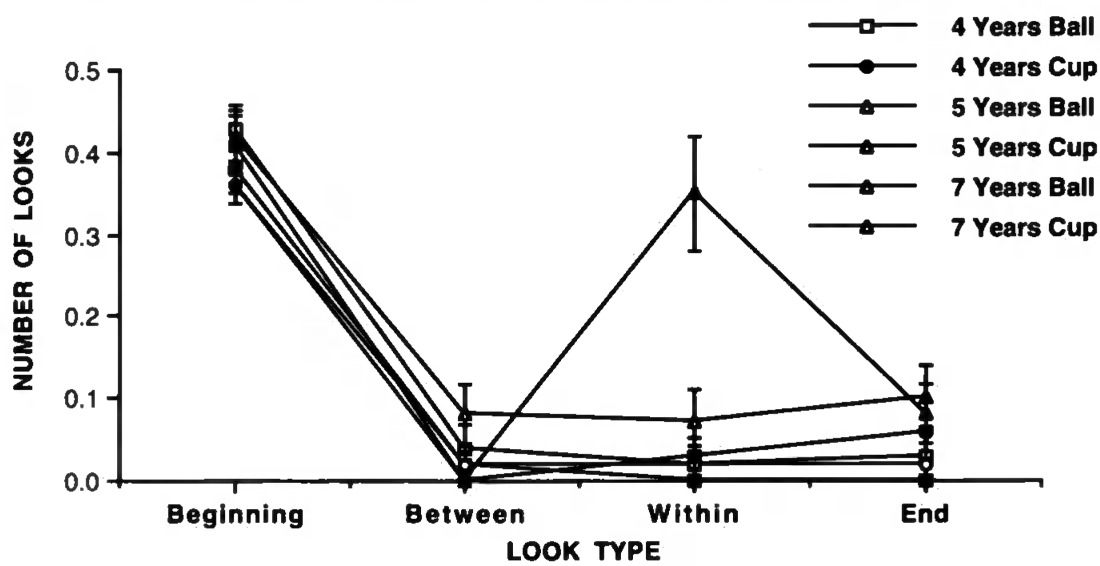


FIGURE 9.2 INTERACTION OF AGE BY DRAWING MODEL BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE



two factors ($F(2,41)=5.44$ $p<.01$). See Table 9.6 for details of these means. This showed that the visually realistic drawers looked at the model more times than the intellectually realistic drawers, and that the five- and seven-year-olds looked at the model more than the four-year-olds (Scheffe $ps<.001$). The follow-up analysis of the interaction revealed no significant differences. It can be seen from Table 9.6 that the mean of the visually realistic group has been inflated by the one visually realistic five-year-old who showed a high level of attention towards this model.

Look type significantly interacted with drawing realism ($F(2,95)=4.05$ $p<.05$*). Follow-up analysis showed that only the visually realistic drawers looked more 'within' and at the 'end' of the drawing. However these two means were again inflated by the one visually realistic five-year-old.

The ANOVA on the ball model showed no significant main effect of drawing realism ($F(1,40)=0.53$ $p>.05$), but did show a significant interaction between look type and drawing realism ($F(3,113)=2.94$ $p<.05$*). Follow-up analysis however revealed that the 'beginning' looks were greater than all other look types for both visually and intellectually realistic drawers. However the visually realistic drawers showed higher levels of 'between' looking in that this was only significantly different from the 'beginning' looks at $p<.01$, as opposed to $p<.001$ for the intellectually realistic. This mean was however inflated by the one visually realistic four-year-old who showed higher than average 'between' looking.

Therefore in general most of the effects found in these ANOVAs were the result of a few subjects performing exceptionally well. Due to the post hoc classification of subjects as either intellectually or visually realistic drawers, there was no control over subject numbers. However it was noticeable that the younger subjects who produced a visually realistic drawings were those children who were attending to the model to a greater extent that the intellectually realistic children of the same age.

* Epsilon correct (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 9.6 MEAN NUMBER OF LOOKS PER DRAWING REALISM AND AGE (CUP TASK)

AGE REALISM	N	4 YEARS	N	5 YEARS	N	6 YEARS	MEAN TOTAL
Intellectual	11	0.10 (0.41)	17	0.10 (0.37)	3	0.15 (0.67)	0.12 (0.48)
Visual	3	0.09 (0.33)	1	0.31 (1.25)	12	0.22 (0.94)	0.21 (0.84)
MEAN TOTAL		0.10 (0.37)		0.21 (0.81)		0.19 (0.80)	

Untransformed means (number of looks) are shown in parentheses.

9.2.1.2.2 Looking Time

A 3 (age) x 2 (gender) x 2 (drawing order) x 2 (drawing model) x 4 (look type) analysis of variance was performed on the time each child spent looking at the model in front of them. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

This ANOVA, like that for the Number of Looks measure, showed a significant main effect of age ($F(2,35)=10.72$ $p<.001$). Follow-up analysis showed that the seven-year-olds paid more attention to the model than the five- and four-year-olds (mean seconds = 1.33, 0.71 and 0.78 respectively). This effect is illustrated in Figure 9.3. There was no significant difference in looking behaviour between the two drawing models ($F(1,35)=0.52$ $p>.05$).

The ANOVA showed a highly significant main effect of look type ($F(2,71)=390.27$ $p<.001$*), an interaction between look type and drawing model ($F(3,93)=9.09$ $p<.001$*) and an interaction between these two factors and age ($F(5,93)=3.94$ $p<.01$*). Follow-up analysis revealed that significantly more time was spent looking at the 'beginning' of the task compared to all other look types (Scheffe ps<.001). The mean seconds were 3.24, 0.08, 0.28 and 0.17 for the 'beginning', 'between', 'within' and 'end look types respectively. Although the follow-up analysis only revealed that the 'beginning' looks were greater than all other look types for both the interactions, as shown in Table 9.7 the cup drawings showed near significant differences between the 'within' and 'between' look types but only for the seven-year-olds. These trends therefore reflect the significant results observed with the results for the Number of Looks measure.

Looking Time and Drawing Realism

Two, 3 (age) x 2 (drawing realism) analyses of variance one for each model, were performed in order to compare the looking time of the visually and intellectually realistic drawers. Due to unequal variances and the standard deviations being proportional to the means, log(10) transformations were performed on the data.

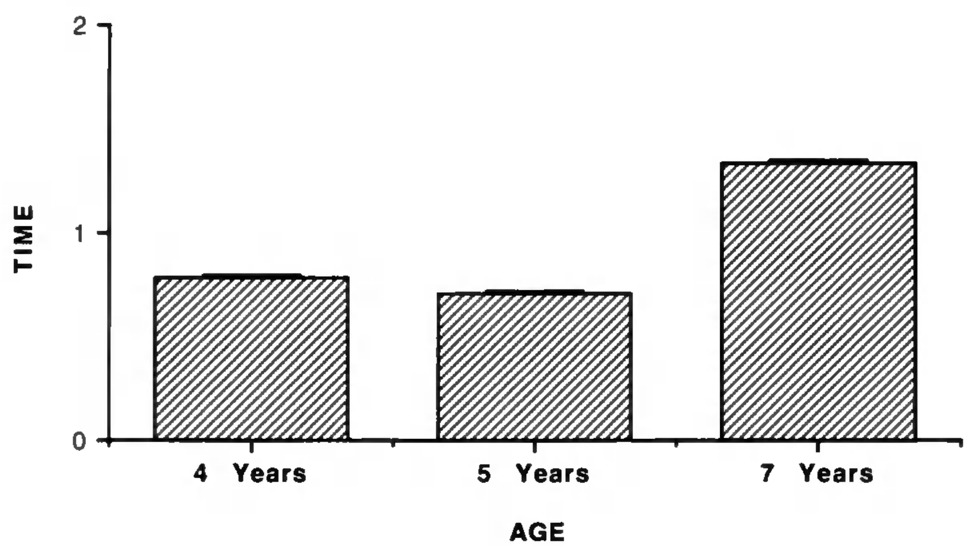
* Epsilon correct (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 9.7 **MEAN LOOKING TIME PER LOOK TYPE, AGE AND DRAWING MODEL**

DRAWING MODEL	AGE	BEGINNING	BETWEEN	WITHIN	END
BALL	4 YEARS	0.59 (3.06)	0.03 (0.10)	0.02 (0.05)	0.03 (0.14)
	5 YEARS	0.59 (3.18)	0.07 (0.02)	0.01 (0.02)	0.01 (0.03)
	7 YEARS	0.72 (4.59)	0.09 (0.31)	0.07 (0.25)	0.07 (0.22)
MEAN TOTAL		**0.63 (3.63)**	**0.04 (0.15)**	**0.03 (0.10)**	**0.04 (0.13)**
CUP	4 YEARS	0.57 (2.85)	0.01 (0.04)	0.00 (0.00)	0.00 (0.00)
	5 YEARS	0.45 (2.08)	0.00 (0.00)	0.04 (0.19)	0.04 (0.15)
	7 YEARS	0.61 (3.58)	0.00 (0.00)	0.29 (1.20)	0.12 (0.49)
MEAN TOTAL		**0.54 (2.86)**	**0.01 (0.01)**	**0.11 (0.46)**	**0.05 (0.22)**

Untransformed means (seconds) are shown in parentheses.

FIGURE 9.3 **MAIN EFFECT OF AGE FOR LOOKING TIME MEASURE**



For the cup model the ANOVA showed significant main effects of drawing realism ($F(1,41)=15.89$ $p<.001$) and age ($F(2,41)=6.81$ $p<.01$), and an interaction between these two factors ($F(2,41)=7.25$ $p<.01$). See Table 9.8 for details of these means. This showed that the visually realistic drawers spent more time looking at the model than the intellectually realistic drawers. Follow-up analysis revealed that the five- and seven-year-olds looked at the model more than the four-year-olds ($ps<.001$), but no significant differences for the interaction. However it can be seen from Table 9.8 that these effects have been inflated by one five-year-old visually realistic subject who showed high levels of attention. There was no significant interaction between look type and drawing realism ($F(2,90)=1.80$ $p>.05^{*}$).

The ANOVA for the ball model showed no significant main effect of drawing realism ($F(1,40)=3.69$ $p>.05$) although the means were in the hypothesised direction i.e. 1.15 seconds for the visually realistic drawers, and 0.84 seconds for the intellectually realistic drawers. There was no significant interaction between look type and drawing realism ($F(2,83)=1.24$ $p>.05^{*}$).

<u>Number of Looks and Looking Time</u>

In order to assess the relationship between the two measures of attention, Pearson Product Moment partial correlations were performed on each child's total number of looks and looking time, separately for each task. Partial correlations were used in order to control for any possible age effects. These showed positive correlations of $r=0.46$ and 0.60 (d.f.=44 $ps<.01$) for the ball and cup tasks respectively.

<u>9.2.1.3</u> <u>STRATEGIES OF ATTENTION</u>

Based on the children's strategic attention towards the drawing models, they were divided into three groups i.e. extensively strategic, limited strategic and non-strategic. Table 9.9 details the number of children in each category for each drawing model. For the ball task there were no significant differences between the three categories and age groups (Fisher Exact Test $ps>.05$).

* Epsilon correct (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 9.8 MEAN LOOKING TIME PER DRAWING REALISM AND AGE (CUP TASK)

AGE REALISM	N	4 YEARS	N	5 YEARS	N	7 YEARS	MEAN TOTAL
Intellectual	11	0.15 (0.76)	17	0.12 (0.51)	3	0.18 (1.33)	**0.15** **(0.87)**
Visual	3	0.13 (0.60)	1	0.37 (2.27)	12	0.27 (1.31)	**0.26** **(1.39)**
MEAN TOTAL		**0.14** **(0.68)**		**0.24** **(1.39)**		**0.23** **(1.32)**	

Untransformed means (seconds) are shown in parentheses.

TABLE 9.9 STRATEGIC ATTENTIONAL CATEGORIES

CATEGORY AGE	EXTENSIVELY STRATEGIC	LIMITED STRATEGIC	NON-STRATEGIC	TOTAL
CUP				
4	1	4	9	14
5	2	2	14	18
7	10	3	2	15
TOTAL	**13**	**9**	**25**	
BALL				
4	3	4	7	14
5	2	7	9	18
7	6	3	6	15
TOTAL	**11**	**14**	**22**	

For the cup task, the four- and five-year-olds showed high levels of non- and limited strategic behaviour, while the seven-year-olds showed high levels of exhaustively strategic behaviour (Fisher Exact Test ps<.05). The seven-year-olds therefore seem to have adopted a higher level of strategic attention for the cup task, i.e. 'within' and 'between' looking. It is possible that the children felt that they needed to attend to the cup while they were actually drawing in order to accurately represent its shape, whereas this was not so necessary for the ball drawing due to the simplicity of its shape.

9.2.1.4 META-AWARENESS QUESTIONS

Table 9.10 details the number of children, for each model and age group, responding either "yes" or "no" to the question of whether they thought they would be able to draw the model even if it was hidden from view. Goodness of Fit tests show all these differences to be significant (ps<.05). In total only 10% of children thought that they would not be able to draw, either or both, the cup and balls if they were hidden from view.

Table 9.11 details the number of children in each of the three awareness categories, which relate to the children's justifications of why they thought they would/would not still be able to draw the models. See Appendix J for full details of these categories. For the cup task, there were no significant differences between the three categories and age groups (Fisher Exact Test ps>.05). For the ball task, the four- and five-year-olds showed high levels of limited or no awareness, while the seven-year-olds showed high levels of limited and extensive awareness of the strategic importance of attending to the model (Fisher Exact Test ps<.05).

It was noted that the two 7-year-olds who answered "no" to the original question, stated that the reason why they would not still be able to draw the models was due to not being able to attend to them. They therefore showed an awareness of the strategic importance of attending to the model. The three 4-year-olds who gave a "no" response did not know why they would not be able to draw the model.

TABLE 9.10 YES/NO RESPONSES

		BALL		CUP	
AGE	N	YES	NO	YES	NO
4 YEARS	14	12	2	11	3
5 YEARS	18	18	0	17	0 †
7 YEARS	15	13	2	15	0
TOTAL		53	7	53	3

† One subject responded with "Dont Know".

TABLE 9.11 META-AWARENESS CATEGORIES

CATEGORY AGE	EXTENSIVE AWARENESS	LIMITED AWARENESS	NO AWARENESS	TOTAL
CUP				
4	0	7	7	14
5	1	12	5	18
7	3	8	4	15
TOTAL	4	27	16	
BALL				
4	0	8	6	14
5	0	11	7	18
7	5	6	4	15
TOTAL	5	25	17	

9.2.1.5 ASSOCIATION BETWEEN MEASURES

In order to assess the relationship between the children's drawing performance, strategy use and metacognitive awareness of the attentional strategy, the Gamma statistic for ordinally scaled variables was used (Siegel & Castellan, 1988). Table 19.2 details these associations separately for each age group and both drawing models. In general the five-year-olds showed strong associations between strategically attending to the model, subsequent drawing performance, and an awareness of this attentional strategy.

More specifically, for the cup drawing the four-year-olds showed a significant negative association between drawing realism and awareness of the effective strategy of continued attention towards the drawing model ($G= -1.00$ $p<.05$). Increased drawing realism was related to reduced awareness of the attentional strategy. For the ball drawing this association was positive ($G= +1.00$ $p<.05$), in that increased realism related in increased awareness. There were significant negative associations between the children's "yes/no" response and both their strategy use and their awareness of this strategy for both models ($ps<.05$). The children who stated that they would be able to draw the cup without it being in front of them, were more strategic in their attentional behaviour and had increased awareness, while the few children who answered "no" were non-strategic and had no awareness of why they would not be able to draw the model.

For the cup task, the five-year-olds showed significant associations between drawing realism and the other three measures. The majority of children were intellectually realistic in their drawing ability, and were non-strategic ($G= +1.00$ $p<.01$), believed that they would be able to draw the model without it being in front of them ($G= +1.00$ $p<.05$), and showed limited awareness of why they thought they could do this ($G= +0.67$ $p<.05$). The majority of children answered "yes" but had been non-strategic in their attentional use ($G= -0.75$ $p<.05$), and had only limited awareness ($G= +1.00$ $p<.01$). The association between strategy use and the awareness measures was just significant ($G= +0.43$ $p=.05$), and showed that although the majority of children were non-strategic in behaviour they actually had some limited awareness of the effective strategy. The one child who used an extensive strategy also showed extensive awareness of this.

TABLE 9.12 GAMMA ASSOCIATIONS BETWEEN MEASURES

MEASURE AGE	DRAWING REALISM	ATTENTIONAL STRATEGY	YES/NO
CUP DRAWING			
4 YEARS			
ATTENTION	-0.13		
YES/NO	+0.90	-1.00 *	
AWARENESS	-1.00 *	+0.36	-1.00 *
5 YEARS			
ATTENTION	+1.00 **		
YES/NO	+1.00 *	-0.75 *	
AWARENESS	+0.67 *	+0.43 †	+1.00 **
7 YEARS			
ATTENTION	+0.67 †		
YES/NO	/	/	
AWARENESS	+0.43	+0.08	/
BALL DRAWING			
4 YEARS			
ATTENTION	+0.30		
YES/NO	+0.00	-1.00 *	
AWARENESS	+1.00 *	+0.07	-1.00 *
5 YEARS			
ATTENTION	+0.64 *		
YES/NO	/	/	
AWARENESS	+1.00 *	+0.66 *	/
7 YEARS			
ATTENTION	+0.22		
YES/NO	+1.00 *	+0.00	
AWARENESS	+0.13	-0.27	+1.00 **

/ could not be computed because the whole sample responded with "yes".
† p=0.05
* p<0.05
** p<0.01

The gamma associations with the "yes/no" response measure, for the five-year-olds with the ball task, could not be computed as all the children responded with "yes". However this age group showed significant positive associations between all other measures (ps<.05). Increased realism related to increased strategic behaviour and increased awareness of this strategy, with this increased awareness being associated with increased attentional strategy use.

The seven-year-olds showed a significant association between drawing realism and attentional strategy use for the cup model only (G= +0.67 p=.05). The majority of children had used an extensive attentional strategy and had produced a visually realistic drawing. For the ball task they showed significant positive associations between the "yes/no" response and both drawing realism and awareness (ps<.05). Answering "yes" was associated with both visually and intellectually realistic children, and with all three awareness categories. The two children who answered "no" were both visually realistic and showed extensive awareness of the attentional strategy.

Summary of Main Findings (Drawing Task)

1: The seven-year-olds produced more visually realistic drawings than the four- and five-year-olds, for both tasks. The majority of children showed comparable performance across the two tasks, with the four- and five-year-olds being intellectually realistic on both, and the seven-year-olds being visually realistic on both.

2: The seven-year-olds paid more attention to the drawing model than both the four- and five-year-olds, with the majority of looking occurring at the 'beginning' of the task. However the seven-year-olds increased their 'within' looking particularly for the cup model.

3: The visually realistic drawers generally paid more attention towards the cup model than the intellectually realistic drawers. There was no corresponding significant difference for the ball task. However, the cup and the ball models showed trends towards higher levels of 'within' and 'between' looking respectively, which would be consistent with an extensive attentional strategy.

4: There was a general developmental increase in the use of extensive strategic attention towards the cup model. However the older age group were not any more strategic than the other age groups when presented with the ball task, possibly due to its simplistic shape.

5: There was a general developmental increase in the children's awareness of the extensive attentional strategy.

6: The five-year-olds showed strong associations between increased strategy use, increased drawing performance, and increased awareness of the necessity of strategically attending to the model.

9.2.2 MEMORY TASK

9.2.2.1 RECALL RESPONSES

An initial one-way within subjects analysis of variance was performed in order to determine whether there was any significant difference between the children's recall responses with the two different sets of cards. Due to equal variances and a normal distribution, no transformation was necessary. The set of cards proved to be an insignificant factor ($F(1,46)=0.87$ $p>.05$). The mean recall score for the 'T' set was 5.51 (standard deviation 2.97) and for the 'H' set 5.04 (standard deviation 2.63), out of the possible twelve. The results were therefore pooled across the two sets of cards in the remaining analyses.

A 3 (age) x 2 (gender) x 2 (presentation order) x 2 (display type) analysis of variance was performed on each child's recall scores. Due to unequal variances and a narrow range of scores, the number of correctly recalled cards was divided by the total number possible i.e. twelve, and an arcsine transformation performed on this proportional score. This revealed a main effect of age ($F(2,35)=18.16$ $p<.001$), in that the 7-year-olds recalled more items than both the 4- and 5-year-olds (Scheffe $ps<.001$). See Table 9.13 for details of these means.

TABLE 9.13 MEAN RECALL SCORES PER DISPLAY TYPE AND AGE

AGE	N	MIXED	GROUPED	MEAN TOTAL
4 YEARS	14	0.34 (3.93)	0.35 (4.00)	**0.34** **(3.96)**
5 YEARS	18	0.35 (4.00)	0.48 (5.28)	**0.41** **(4.64)**
7 YEARS	15	0.52 (5.87)	0.88 (8.67)	**0.70** **(7.27)**
MEAN TOTAL		**0.40** **(4.60)**	**0.57** **(5.98)**	

Untransformed means (number of cards recalled) are shown in parentheses.

The ANOVA also showed a main effect of display type (F(1,35)=11.96 p<.01), in that the grouped display type led to significantly more pictures being recalled than the mixed display type. This factor also interacted with age (F(2,35)=4.27 p<.05) revealing that this pattern of results was only significant for the 7-year-olds (Scheffe F(2,35)= 18.80 p<.05), while the 4- and 5-year-olds showed no significant difference between the two display types (Scheffe ps>.05). This effect is detailed in Table 9.13 and illustrated in Figure 9.4. Unlike Phase 1, no interaction between display type and presentation order was noted (F(1,35)=0.79 p>.05).

9.2.2.2 ARC CLUSTERING

A 3 (age) x 2 (presentation order) x 2 (display type) analysis of variance was performed on the ARC clustering scores. Due to unequal variances and a proportional score, an arcsine transformation was performed. Those children who's ARC scores were undefined (recalled from only one category, or just one card from each category recalled) were entered into the analyses as 'missing data'. This showed a significant main effect of display type (F(1,27)=8.54 p<.01), where the grouped display type led to greater clustering at recall than the mixed display type (mean ARC scores = 0.55 and 0.12 respectively). This factor did not significantly interact with age (F(2,27)=3.03 p>.05), suggesting that this effect was evident at all ages.

9.2.2.3 CLUSTERING CATEGORIES

Based on the children's ARC score they were divided into three categories i.e. extensively strategic, limited strategic and non-strategic. Table 9.14 details the number of children in each category for each display type. For the mixed display type there were no significant differences between the three strategic categories and age groups (Fisher Exact Test ps>.05). For the grouped display type there was one significant difference in that more seven-year-olds were either limited and extensive in their strategy use while the five-year-olds were more non-strategic (Fisher Exact Test ps<.05).

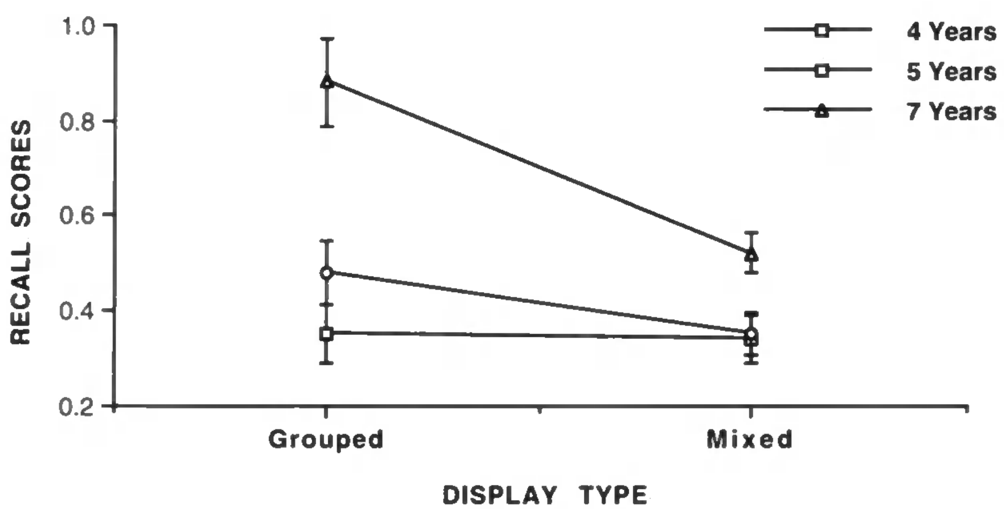
9.2.2.4 RECALL PERFORMANCE AND CLUSTERING CATEGORIES

A two-way 3 (age) x 3 (category), and a one-way 3 (category) analysis of variance for

TABLE 9.14 STRATEGIC CLUSTERING CATEGORIES

CATEGORY AGE	EXTENSIVELY STRATEGIC	LIMITED STRATEGIC	NON-STRATEGIC	UNDEFINED	TOTAL
MIXED					
4	3	2	4	5	14
5	4	4	5	5	18
7	3	2	9	1	15
TOTAL	10	8	18	11	
GROUPED					
4	6	3	0	5	14
5	6	4	5	3	18
7	9	6	0	0	15
TOTAL	21	13	5	8	

FIGURE 9.4 INTERACTION OF AGE BY DISPLAY TYPE FOR MEMORY RECALL SCORES



the mixed and grouped display types respectively, were performed on the arcsine transformed recall scores, in order to compare the relationship between recall performance and the use of the clustering strategy at recall. The factor of age could not be included for the grouped condition due to no four- or seven-year-olds falling into the non-strategic category. There were no significant main effects of clustering category for either the mixed or the grouped display type ($F(2,27)=1.63$ and $F(2,36)=0.92$ respectively, $ps>.05$). Therefore recall scores did not vary significantly with the clustering category based on the ARC scores.

9.2.2.5 META-MEMORY QUESTIONS

Table 9.15 details the number of children in each age group who responded with either 'grouped', 'mixed', 'neither', 'don't know' or 'did not understand', to the question of which arrangement would help them remember the cards more. Fisher exact probability tests on the grouped and mixed responses showed that more 7-year-olds chose the grouped arrangement than the 4-year-olds (Fisher Exact Test $p<.05$). Unlike Phase 1, the 5-year-olds did not show any significant difference in responding to the 7-year-olds, this age group therefore showed an improvement in performance between testing phases. The 4- and 5-year-olds only differed with regard to the 'did not understand' and 'grouped' responses.

Table 9.16 details the number of children in each of the three awareness categories. These relate to the children's justifications of why they thought the arrangement they had chosen would help them to remember the cards. See Appendix J for full details of these categories. In general the 4-year-olds showed no awareness of how categorical clustering can aid recall, the 5-year-olds showed either no or extensive awareness, while the 7-year-olds were extensively aware of this mnemonic strategy (Fisher Exact Test $ps<.05$).

Eleven out of the fourteen 7-year-olds, and six out of the eleven 5-year-olds who selected the grouped arrangement subsequently showed extensive awareness of how this would help them to remember the cards. The majority of 4-year-olds did not seem to understand the task and just selected individual cards, therefore resulting in a high

TABLE 9.15 GROUPED/MIXED CHOICE

AGE	GROUPED	MIXED	NEITHER	DONT KNOW	DID NOT UNDER-STAND
4 YEARS	1	3	0	2	8
5 YEARS	11	3	0	1	3
7 YEARS	14	1	0	0	0
TOTAL	26	7	0	3	11

TABLE 9.16 META-AWARENESS CATEGORIES

CATEGORY AGE	EXTENSIVE AWARENESS	LIMITED AWARENESS	NO AWARENESS	TOTAL
4 YEARS	0	2	12	14
5 YEARS	6	4	8	18
7 YEARS	11	1	3	15
TOTAL	17	7	23	

proportion of 'did not understand' responses to the original choice of arrangement, and a high proportion of children in the 'no awareness' category.

9.2.2.6 ASSOCIATION BETWEEN MEASURES

Table 9.17 details the results of the associations between measures. Spearman correlation coefficients were used to compare the relationship between recall performance and clustering categories, the selection of the mixed or grouped arrangement, and the awareness categories. Comparisons between the latter three measures were assessed using the Gamma statistic for ordered variables. All these associations were assessed separately for the two display types and the three age groups. In general, there was an increase with age in awareness of the effective mnemonic strategy of clustering items, but it was not until seven years of age that this was associated with actual use of this strategy.

More specifically, the four-year-olds only showed a significant correlation between recall and the mixed/grouped choice for the mixed display type ($r_S = 0.52$ n=14 p=.05). Therefore increased recall performance related to an increasing ability to select the grouped arrangement as a means of aiding recall. As shown in Table 9.15, the majority of this age groups did not understand the task, however those who subjects who selected the mixed arrangement, and the one child who selected the grouped, showed increasing recall ability respectively.

The five-year-olds showed no significant correlations between recall performance, strategy use and metacognitive awareness, for either display type. There was however a significant association between the mixed/grouped choice and awareness of the clustering strategy (G= +0.84 p<.01). Those children who selected the mixed arrangement showed no awareness of how this would aid recall, while those children selecting the grouped arrangement showed more extensive awareness.

For the seven-year-olds, there was a significant correlation between recall and awareness for the mixed display type ($r_S = 0.51$ n=15 p=.05), in that increased recall

TABLE 9.17 CORRELATIONS AND GAMMA ASSOCIATIONS BETWEEN MEASURES

DISPLAY TYPE	MIXED		GROUPED		
MEASURE	RECALL (r_s)	CLUSTERING CATEGORY (Gamma)	RECALL (r_s)	CLUSTERNG CATEGORY (Gamma)	MIXED/ GROUP (Gamma)
4 YEARS					
CLUSTERING	+0.13		-0.33		
MIX/GROUP	+0.52 †	+0.18	+0.05	+0.00	
AWARENESS	+0.18	+0.14	-0.05	+1.00 ~	+0.38
5 YEARS					
CLUSTERING	-0.30		+0.10		
MIX/GROUP	-0.03	+0.33	+0.41	+0.33	
AWARENESS	+0.01	-0.28	+0.17	+0.13	+0.84 **
7 YEARS					
CLUSTERING	-0.09		+0.29		
MIX/GROUP	+0.22	+1.00 *	+0.34	-1.00 *	
AWARENESS	+0.51 *	+0.14	+0.47	+0.80 *	+0.57

~ non-significant due to low subject numbers.
† $p=0.05$
* $p<0.05$
** $p<0.01$

related to increased awareness of the effectiveness of categorical clustering. Clustering categories for the grouped display type showed a negative association with the mixed/ grouped choice ($G= -1.00$ $p<.05$), in that those children selecting the grouped arrangement was associated with limited and extensive clustering, while the one subject who selected the mixed arrangement was extensively strategic.

Extensive strategy use for the grouped display type was also associated with an extensive awareness of how it aided recall ($G= +0.80$ $p<.05$). This condition also showed a significant positive association between the mixed/grouped choice and clustering category ($G= +1.00$ $p<.05$). Selecting the grouped arrangement was associated with all three clustering categories, while the one subject who selected the mixed arrangement was non-strategic at recall.

Summary of Main Findings (Memory Task)

1: The seven-year-olds showed significantly higher levels of recall than the four- and five-year-olds. The seven-year-olds showed increased performance with the grouped display type.

2: The grouped display type led to greater clustering of items at recall, for all ages, and subsequently greater proportions of children in the extensively strategic category.

3: There was no difference in recall performance between the children in the three strategic categories.

4: There was a general developmental increase in the children's awareness of how categorical clustering aided recall.

5: The four-year-olds showed no awareness of categorical clustering as an mnemonic aid. The five-year-olds showed an ability to recognise that categorical clustering would aid recall and why this was effective. The seven-year-olds showed how increased clustering at recall was associated with the selection of the grouped arrangement, and awareness of how this aided recall ability.

9.2.3 SELECTIVE ATTENTION TASK

9.2.3.1 SAME/DIFFERENT JUDGEMENTS

Total Number of Accurate Judgements

The total number of accurate judgements each child made across pairs was calculated. Due to unequal variances and a narrow range of scores the number of accurate judgements was divided by the total number possible i.e. four, and an arcsine transformation was performed. Due to an unbalanced design a three-way analysis of variance incorporating age, practice order and experimental order was not possible. A one-way between subjects ANOVA showed no effect of the two practice orders (i.e. same/different vs. different/ same) ($F(1,45)=0.74$ $p>.05$). A two-way between subjects ANOVA showed no significant effect of the four experimental orders ($F(3,35)=1.26$ $p>.05$), but did reveal a significant main effect of age ($F(2,35)=14.29$ $p<.001$). Scheffe follow-up analysis on the main effect of age showed that the 7-year-olds produced significantly higher scores than the 5- and 4-year-olds (Scheffe $ps<.01$). The mean number of accurate judgements out of four were 3.60, 2.56 and 1.77 respectively. This effect is illustrated in Figure 9.5.

Age Differences

The number of children who responded either same or different for each house pair and age group are shown in Table 9.18.

Pair 1 (same) Each age group generally had no difficulty in deciding that this pair of houses was the same. There were therefore no significant age differences (Fisher Exact Tests $ps>.05$).

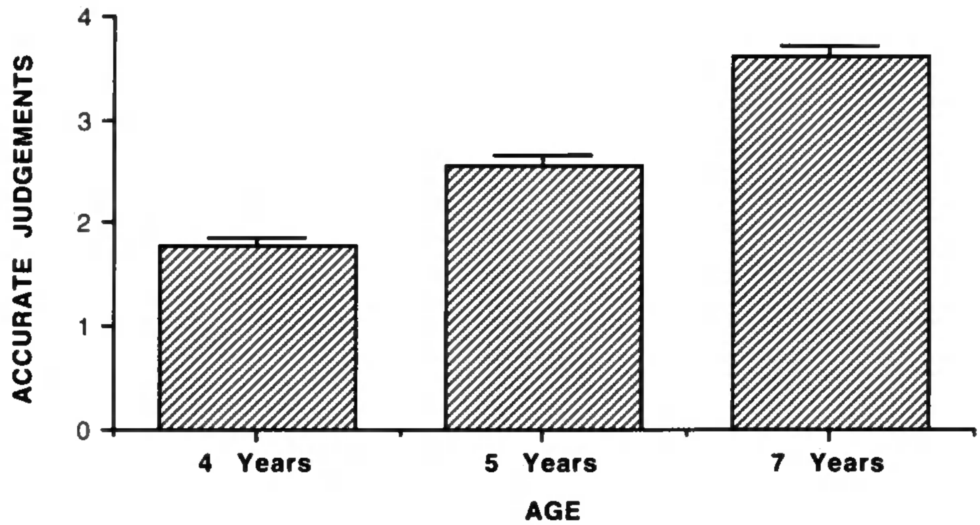
Pair 2 (1 difference) Significantly more seven-year-olds correctly stated that this pair of houses was different, compared to the four-year-olds ($X^2=10.30$ d.f.=1 $p<.001$) and the five-year-olds (Fisher Exact Test $p<.05$). Therefore both the seven- and five-year-olds seem to have shown an improvement between the two testing phases.

Pair 3 (2 differences) Significantly more four-year-olds incorrectly stated that this

TABLE 9.18 **SAME/DIFFERENT JUDGEMENTS FOR EACH HOUSE PAIR**

	PAIR 1		PAIR 2		PAIR 3		PAIR 4	
AGE	SAME	DIFF-ERENT	SAME	DIFF-ERENT	SAME	DIFF-ERENT	SAME	DIFF-ERENT
4	10	4	10	4	8	6	9	5
5	15	3	7	11	6	12	11	7
7	14	1	1	14	1	14	3	12
TOTAL	39	8	18	29	15	32	23	24

FIGURE 9.5 **MAIN EFFECT OF AGE FOR THE TOTAL NUMBER OF ACCURATE JUDGEMENTS**



pair of houses was the same compared to the seven-year-olds who stated correctly that they were different (Fisher Exact Test $p<.01$). Therefore the four-year-olds showed an improvement in performance as they were no longer significantly different from the five-year-olds.

Pair 4 (different locations) Unlike Phase 1, more seven-year-olds correctly stated that this pair of houses was different compared to the other two age groups (X^2 $ps<.05$). The seven-year-olds therefore improved in performance on this pair of houses.

Pair Differences

Comparison of performance across the four house pairs was analysed separately for each age group. For the four- and seven-year-olds a Cochran Q test for related samples showed there to be no significant differences between pairs ($Q=6.73$ and 2.25 respectively, d.f.=3 $p>.05$). For the five-year olds the Cochran test was nearly significant ($Q=7.71$ d.f.=3 $p>.05$). As can be seen from Table 9.18 their performance on Pair 4 deteriorated slightly, however a post hoc Binomial test showed no difference in performance between Pairs 1 and 4 (Binomial d.f.=1 $p>.025$).

Therefore Pair 1 seems to have been relatively easy for each age group i.e. where the two houses were the same. The 5- and 7-year-olds performed well on Pairs 2 and 3 where there were differences, while the 7-year-olds alone were able to accurately determine that Pair 4 was different.

9.2.3.2 WINDOW OPENING STRATEGIES

Table 9.19 details the number of children using the three different types of window opening strategies. See Appendix K and Chapter 8 Section 1.5 for full details of these. For all four house pairs the four-year-olds used a limited window opening strategy, while the five- and seven-year-olds used an exhaustive strategy (Fisher Exact Test $ps<.05$).

9.2.3.3 TOTAL ACCURATE JUDGEMENTS AND OPENING STRATEGY

In order to compare the relationship between the child's total number of accurate

TABLE 9.19 WINDOW OPENING STRATEGIES

STRATEGY PAIR/AGE	EXHAUSTIVELY STRATEGIC	LIMITED STRATEGIC	NON-STRATEGIC
PAIR 1			
4 YEARS	0	12	2
5 YEARS	7	7	4
7 YEARS	9	3	3
TOTAL	16	22	9
PAIR 2			
4 YEARS	0	12	2
5 YEARS	9	6	3
7 YEARS	9	3	3
TOTAL	18	21	8
PAIR 3			
4 YEARS	0	12	2
5 YEARS	8	6	4
7 YEARS	10	3	2
TOTAL	18	21	8
PAIR 4			
4 YEARS	0	11	3
5 YEARS	5	9	4
7 YEARS	7	5	3
TOTAL	12	25	10

judgements and their window opening strategy, the strategy that each child used most predominantly across the four house pairs was assessed. If there was a tie between two strategies, the higher level strategy was recorded. A 3 (category) between subjects analysis of variance was performed on the total number of accurate judgements of similarity/dissimilarity. Due to equal variances and a normal distribution, no transformation was necessary. The factor of age could not be included in the analysis due to no four-year-olds falling into the exhaustive category. The ANOVA showed a significant main effect of strategic category ($F(2,44)=6.50$ $p<.01$). Scheffe follow-up analysis revealed that those children who used the exhaustive strategy were able to accurately judge the similarity of the house pairs more than the children who used the limited strategy ($p<.01$). The non-strategic category showed no significant difference to either the limited or the exhaustive category, however subject numbers were low [mean accurate judgements = 2.71 (n=7), 2.05 (n=21) and 3.26 (n=19) respectively]. See Figure 9.6 for an illustration of this effect.

9.2.3.4 META-AWARENESS QUESTIONS

Table 9.20 details the number of children in each of the three awareness categories, which relate to the children's justifications of their same/difference response. See Appendix K and Chapter 8 Section 1.5 for full details of these categories. For Pairs 1 and 2 the four- and five-year-olds showed no awareness of the necessity of comparing matching pictures across the house pairs, while the seven-year-olds showed extensive awareness of this ability (Fisher Exact Test $p<.05$). For Pair 3 the four-year-olds showed no awareness, while the five- and seven-year-olds showed extensive awareness (Fisher Exact Test ps<.05). Pair 4 showed no significant age effects (ps>.05).

9.2.3.5 ASSOCIATION BETWEEN MEASURES

The Gamma statistic was used to compare the relationship between the same/different judgement, the window opening strategies and the awareness categories. All these associations were assessed separately for the four house pairs and the three age groups. The results of these comparisons are detailed in Table 9.21. In general, the use of the more exhaustive opening strategy was associated with an accurate judgement of the

FIGURE 9.6 MAIN EFFECT OF OPENING STRATEGY FOR THE TOTAL NUMBER OF ACCURATE JUDGEMENTS

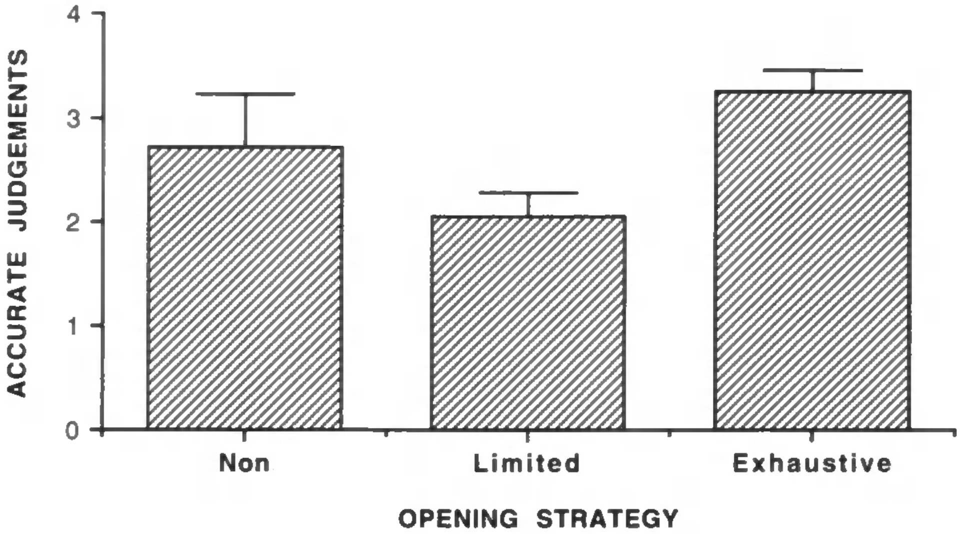


TABLE 9.20 META-AWARENESS CATEGORIES

CATEGORY PAIR/AGE	EXTENSIVE AWARENESS	LIMITED AWARENESS	NO AWARENESS
PAIR 1			
4 YEARS	4	3	7
5 YEARS	5	7	6
7 YEARS	11	4	0
TOTAL	20	14	13
PAIR 2			
4 YEARS	1	3	10
5 YEARS	6	5	7
7 YEARS	13	1	1
TOTAL	20	9	18
PAIR 3			
4 YEARS	4	2	8
5 YEARS	11	3	4
7 YEARS	11	2	2
TOTAL	26	7	14
PAIR 4			
4 YEARS	6	5	3
5 YEARS	12	5	1
7 YEARS	11	4	0
TOTAL	29	14	4

TABLE 9.21 GAMMA ASSOCIATIONS BETWEEN MEASURES

	4 YEARS		5 YEARS		6 YEARS	
MEASURE	S/D	Strategy	S/D	Strategy	S/D	Strategy
PAIR 1						
Strategy	+0.50		+0.20		+1.00 **	
Awareness	+1.00 *	+1.00 *	+1.00 **	+0.28	+1.00 *	+0.75 *
PAIR 2						
Strategy	-0.50		+0.39		+0.50	
Awareness	+0.05	+1.00 *	+0.69 *	+0.56 *	+0.86 *	+0.83 **
PAIR 3						
Strategy	-0.17		+0.73 *		+1.00 **	
Awareness	+0.78 *	+1.00 *	+0.76 *	+0.18	+1.00 **	+0.43
PAIR 4						
Strategy	+0.07		-0.39		+0.00	
Awareness	-0.29	+0.93 *	+0.05	+0.36	+0.82 †	+0.40

S/D Same/Different judgement.
† $p=0.05$
* $p<0.05$
** $p<0.01$

similarity/dissimilarity of the house pairs, and awareness of the necessity of comparing homologous windows.

More specifically, the four-year-olds showed significant positive associations between the same/difference response and awareness for Pairs 1 and 3, and between the opening strategy and awareness for all four pairs ($ps<.05$). An accurate judgement was associated with extensive awareness of the necessity of comparing homologous windows, which in turn was associated with a limited opening strategy. An inaccurate judgement was associated with no awareness, which was in turn associated with being either limited or non-strategic.

The five-year-olds showed a significant association between the same/different judgement and opening strategy for Pair 3 ($G= +0.73$ $p<.05$), in that an inaccurate judgement was associated with being limited or non-strategic, while an accurate judgement was associated with the use of an exhaustive window opening strategy. The same/difference judgement was also significantly associated with awareness categories for Pairs 1, 2 and 3 ($ps<.05$). The majority of children who made an accurate judgement showed either limited or extensive awareness of the basis of their decision, while the children who made an inaccurate judgement showed only limited or no awareness. For Pair 2, use of an exhaustive opening strategy was associated with extensive awareness ($G= +0.56$ $p<.05$). Pair 4 showed no significant associations ($ps>.05$).

For the seven-year-olds the same/difference judgement was significantly associated with strategy use for Pairs 1 and 3 ($ps<.01$), in that an accurate judgement followed the use of an exhaustive window opening strategy. The same/different judgement was also positively associated with awareness categories for all four house pairs ($ps<.05$ for Pairs 1 to 3, $p=.05$ for Pair 4). The majority of children giving accurate judgements were able to extensively justify why the house pairs were the same or different. This extensive awareness was associated with the use of an exhaustive window opening strategy for Pairs 1 and 2 ($ps<.05$).

Summary of Main Findings (Selective Attention Task)

1: More seven-year-olds accurately assessed the similarity/dissimilarity of the house pairs than the four- and five-year-olds.

2: If the two houses were the same the children had no difficulty in judging this. The five- and seven-year-olds showed high performance where there was either one or two differences, while the seven-year-olds alone were able to accurately judge that a change in the spatial location of the pictures resulted in dissimilarity between house pairs.

3: There was a general developmental increase in the use of exhaustive window opening strategies.

4: The use of the exhaustive strategy led to greater accuracy in assessing the similarity/dissimilarity of the house pairs.

5: There was a general developmental increase in the children's awareness of the necessity to compare matching pictures across house pairs in order to justify their judgement.

6: The use of a limited window opening strategy in the four-year-olds, and an exhaustive opening strategy for the five- and seven-year-olds, was associated with an accurate same/difference judgement and extensive awareness of the necessity to compare matching pictures across house pairs, in order to justify this judgement.

9.2.4 TASK EFFECTS

In order to assess how the children's abilities compared across the three tasks, Spearman rank-order correlation coefficients were used to compare performance levels, and the Friedman two-way analysis of variance by ranks was used to compare strategic and awareness categories, separately for each age group.

9.2.4.1 PERFORMANCE

The children's drawing realism for both the cup and ball task, their recall score for the mixed and grouped display type, and their total same/difference score across the four house pairs, were correlated with each other. As can be seen from Table 9.22, there were

TABLE 9.22 CORRELATIONS FOR COMPARISON OF PERFORMANCE BETWEEN TASKS

	Drawing Realism (Ball Task)	Drawing Realism (Cup Task)	Same/Difference Judgement
FOUR-YEAR-OLDS			
Recall (Mixed)	+0.00	-0.31	-0.15
Recall (Grouped)	+0.43	-0.20	+0.21
Same/Difference	+0.19	+0.53 *	
FIVE-YEAR-OLDS			
Recall (Mixed)	+0.15	-0.24	+0.25
Recall (Grouped)	+0.33	-0.14	+0.03
Same/Difference	-0.22	+0.15	
SEVEN-YEAR-OLDS			
Recall (Mixed)	-0.15	-0.16	+0.20
Recall (Grouped)	+0.48	+0.06	+0.04
Same/Difference	+0.59 *	+0.42	

* $p<0.05$

only a few significant correlations. For the four-year-olds increased drawing realism on the cup task significantly correlated with increased selective attention performance (r_s =0.53 n=14 p<.05). For the seven-year-olds, increased drawing realism on the ball task significantly related to increased selective attention performance (r_s =0.59 n=15 p<.05).

However it must be noted that this analysis could have been affected by narrow ranges of scores and low subject numbers. Figures 9.7, 9.8 and 9.9 illustrate more clearly the general lack of relationship between measures for the four-, five- and seven-year-olds respectively.

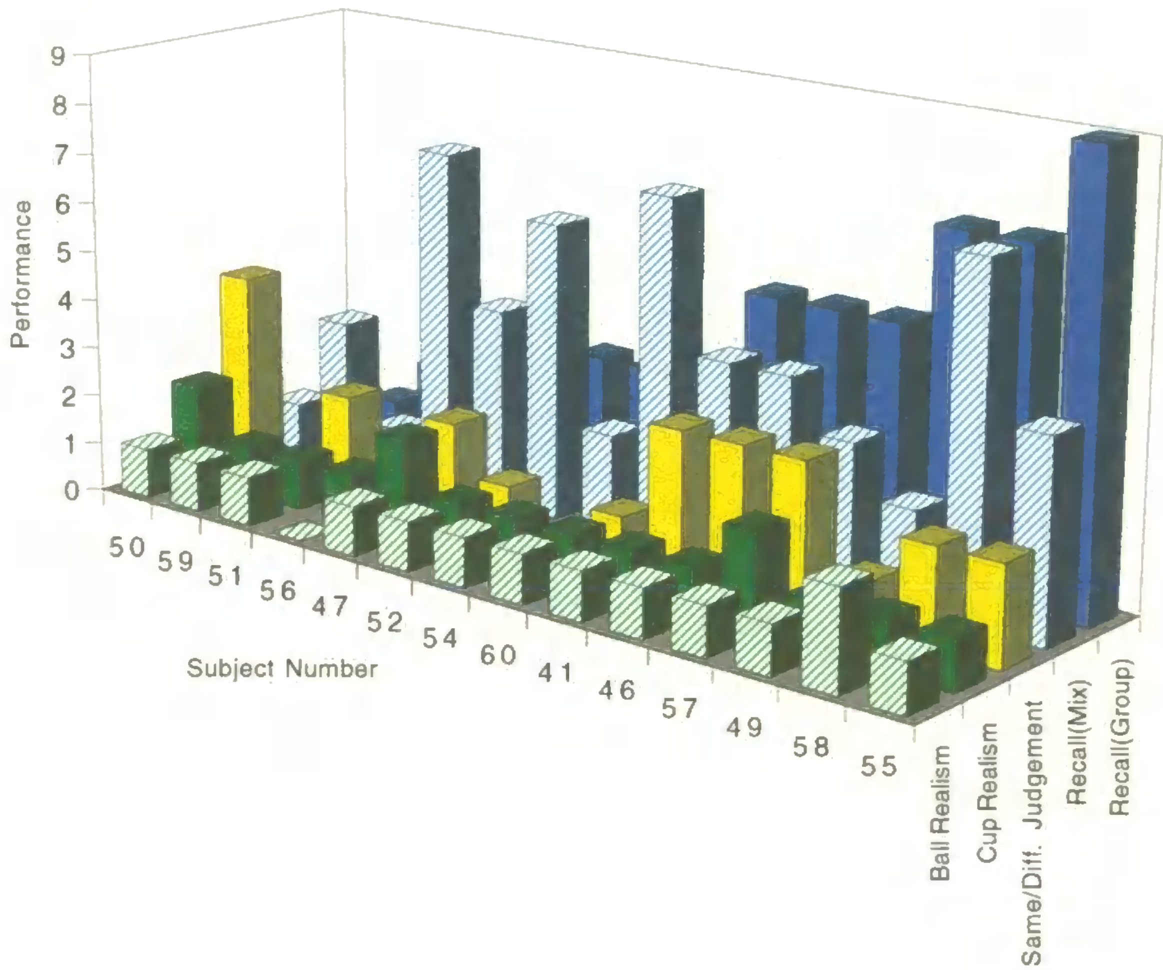
9.2.4.2 STRATEGIC ABILITIES

Friedman tests were used to assess whether children's strategic ability (non-strategic, limited strategic, extensively strategic) differed across the three tasks. Therefore for each age group, four tests were calculated between strategic attentional ability (ball and cup tasks), memory clustering ability (mixed and grouped display type) and the most predominant window opening strategy used across the four house pairs. The results of these are shown in Table 9.23.

In opposition to Phase 1, the five-year-olds showed no significant differences, while the four-year-olds were now showing differences in their strategic behaviour between the different tasks. They showed significant differences for both the ball and the cup task compared to the grouped display type and their window opening strategy (F_r=8.62 d.f.=2 p<.05 and 11.10 d.f.=2 p<.01 respectively). Multiple comparisons between tasks revealed that for both of these, the five-year-olds strategic attention on the drawing task was significantly lower than their clustering ability on the memory task. Therefore the children were reacting to the prompt to use the strategy.

The seven-year-olds showed significant differences for both the ball and the cup task compared to the mixed display type and their window opening strategy (F_r=8.89 d.f.=2 p<.05 and 9.80 d.f.=2 p<.01 respectively). For both of these follow-up analysis revealed

FIGURE 9.7 FOUR-YEAR-OLDS PERFORMANCE COMPARISON



NOTES:

The subjects are ranked in order of their recall performance on the memory task with the grouped display type [labelled 'Recall(Group)'].

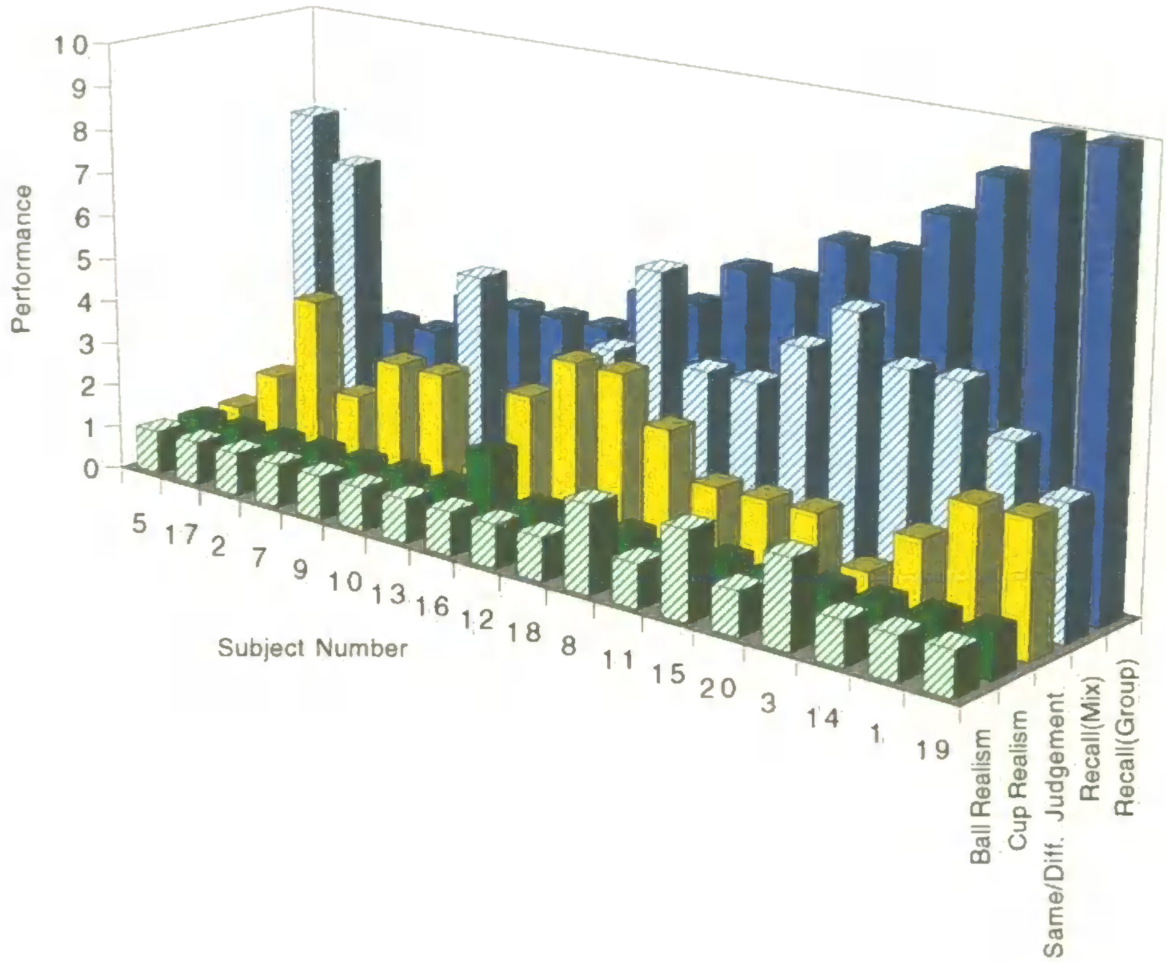
The scales are different for the three tasks.

For the drawing tasks (labelled 'Ball Realism' and 'Cup Realism') the children scored two if they visually realistic, one if they were intellectually realistic and zero if they were neither of these e.g. they scribbled.

For the selective attention task (labelled 'Same/Diff. Judgement') the childrens' scores ranged from zero to four correct judgements.

For the memory task [labelled 'Recall(Mix)' and 'Recall(Group)'] the childrens' scores ranged from zero to twelve cards recalled.

FIGURE 9.8 FIVE-YEAR-OLDS PERFORMANCE COMPARISON



NOTES:

The subjects are ranked in order of their recall performance on the memory task with the grouped display type [labelled 'Recall(Group)'].

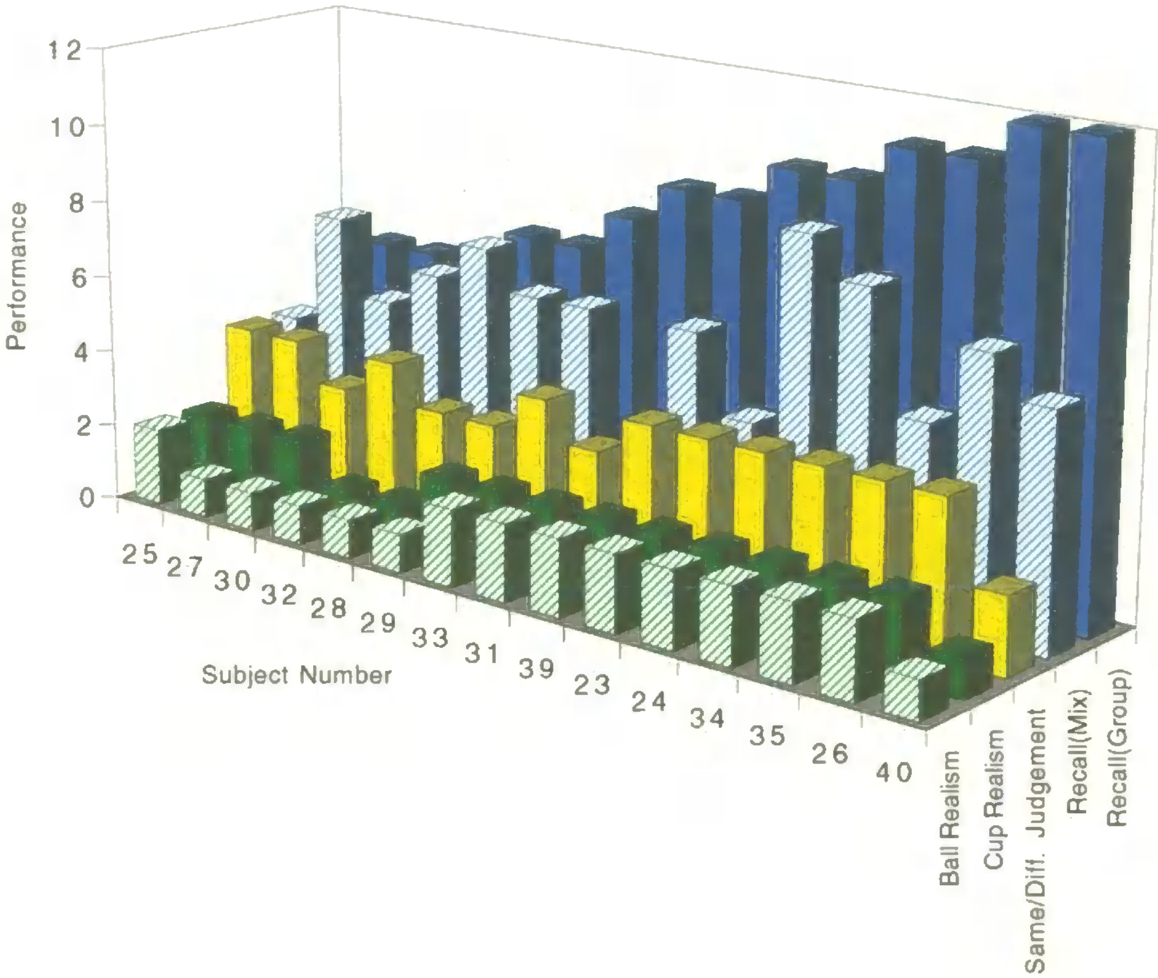
The scales are different for the three tasks.

For the drawing tasks (labelled 'Ball Realism' and 'Cup Realism') the children scored two if they visually realistic, one if they were intellectually realistic and zero if they were neither of these e.g. they scribbled.

For the selective attention task (labelled 'Same/Diff. Judgement') the childrens' scores ranged from zero to four correct judgements.

For the memory task [labelled 'Recall(Mix)' and 'Recall(Group)'] the childrens' scores ranged from zero to twelve cards recalled.

FIGURE 9.9 SEVEN-YEAR-OLDS PERFORMANCE COMPARISON



NOTES:

The subjects are ranked in order of their recall performance on the memory task with the grouped display type [labelled 'Recall(Group)'].

The scales are different for the three tasks.
For the drawing tasks (labelled 'Ball Realism' and 'Cup Realism') the children scored two if they visually realistic, one if they were intellectually realistic and zero if they were neither of these e.g. they scribbled.
For the selective attention task (labelled 'Same/Diff. Judgement') the childrens' scores ranged from zero to four correct judgements.
For the memory task [labelled 'Recall(Mix)' and 'Recall(Group)'] the childrens' scores ranged from zero to twelve cards recalled.

TABLE 9.23 FRIEDMAN TESTS FOR COMPARISON OF STRATEGIC ABILTITY BETWEEN TASKS

TASK COMPARISONS †	SUM OF RANKS DRAW	MEM.	S.A.	F_r	D.F.	P.
FOUR-YEAR-OLDS						
Att.(ball) / Cluster(mixed) / WO	16.0	17.5	20.5	1.556	2	n.s.
Att.(ball) / Cluster(grouped) / WO	14.0*	24.0*	16.0	8.615	2	<0.05
Att.(cup) / Cluster(mixed) / WO	15.0	18.0	21.0	2.667	2	n.s.
Att.(cup) / Cluster(grouped) / WO	12.0*	25.0*	17.0	11.097	2	<0.01
FIVE-YEAR-OLDS						
Att.(ball) / Cluster(mixed) / WO	21.5	27.0	29.5	3.268	2	n.s.
Att.(ball) / Cluster(grouped) / WO	26.0	30.0	34.0	2.977	2	n.s.
Att.(cup) / Cluster(mixed) / WO	20.0	28.0	30.0	5.091	2	n.s.
Att.(cup) / Cluster(grouped) / WO	23.5	32.0	34.5	5.783	2	n.s.
SEVEN-YEAR-OLDS						
Att.(ball) / Cluster(mixed) / WO	28.0	21.5*	34.5*	8.895	2	<0.05
Att.(ball) / Cluster(grouped) / WO	25.0	31.5	33.5	4.051	2	n.s.
Att.(cup) / Cluster(mixed) / WO	31.0	20.0*	33.0*	9.800	2	<0.01
Att.(cup) / Cluster(grouped) / WO	29.5	29.0	31.5	0.483	2	n.s.

† Att.(ball) = Strategic attention for ball drawing task.
Att.(cup) = Strategic attention for cup drawing task.
Cluster(mixed) = Clustering strategy for mixed display type.
Cluster(grouped) = Clustering strategy for grouped display type.
WO = Window opening strategy for selective attention task.

* Significant differences at follow-up.

that the children's memory clustering ability with the mixed display type was significantly lower than their strategic window opening ability. Therefore when the mnemonic strategy was not prompted by the display of the cards at encoding, there was a reduction in strategic ability.

9.2.4.3 META-AWARENESS

Table 9.24 details the results of the Friedman tests which were calculated to assess whether the children's meta-awareness (no awareness, limited awareness, extensive awareness) differed across the three tasks. Therefore for each age group, two tests were calculated between awareness of the attentional strategy in the drawing task (ball and cup), metamemory awareness and the most predominant awareness category shown across the four house pairs on the selective attention task.

All comparisons were shown to be significant (ps<.05). Multiple comparisons between tasks showed that, for the four-year-olds there were no significant differences between sums of ranks, however both the five- and seven-year-olds showed reduced awareness on the ball and the cup tasks compared to their awareness of the necessity to compare homologous windows in order to justify their judgement on the selective attention task.

Summary or Main Findings (Task Effects)

1: The four- and seven-year-olds showed some comparable performance across the three tasks, in that increased drawing ability, on the cup and the ball task respectively, correlated with increased accuracy to differentiate the house pairs on the selective attention task.

2: The four-year-olds showed superior ability to use the mnemonic strategy when it was prompted, than they did to use an attentional strategy in the drawing task. The six-year-olds showed an increased ability to use the exhaustive window opening strategies than they did to use the mnemonic strategy, when it was *not* prompted.

3: The five- and seven-year-olds showed increased awareness of the necessity to compare homologous windows in the selective attention task, compared to their awareness of the attentional strategy in the drawing task.

TABLE 9.24 FRIEDMAN TESTS FOR COMPARISON OF METACOGNITIVE AWARENESS BETWEEN TASKS

TASK COMPARISONS †	SUM OF RANKS DRAW	MEM.	S.A.	F_r	D.F.	P.
FOUR-YEAR-OLDS						
Drawing(ball) / Metamemory / SA	29.5	22.0	32.5	7.091	2	<0.05
Drawing(cup) / Metamemory / SA	28.5	22.5	33.0	6.727	2	<0.05
FIVE-YEAR-OLDS						
Drawing(ball) / Metamemory / SA	28.0*	33.5	46.5*	12.448	2	<0.01
Drawing(cup) / Metamemory / SA	30.5*	32.0	45.5*	8.951	2	<0.05
SEVEN-YEAR-OLDS						
Drawing(ball) / Metamemory / SA	22.5*	30.5	37.0*	13.613	2	<0.01
Drawing(cup) / Metamemory / SA	21.0*	31.0	38.0*	15.368	2	<0.001

† SA = Selective Attention task.
* Significant differences at follow-up.

9.3 DISCUSSION

9.3.1 DRAWING TASK

The seven-year-olds showed superior drawing performance compared to the four- and five-year-olds, on both drawing tasks. This was therefore an improvement in performance for the older age group in comparison to Phase 1, where this pattern of results was only evident for the ball task. Consistent with Phase 1, the three age groups showed comparable performance across tasks, however the seven-year-olds improvement was again evident in that although the majority of four- and five-year-olds remained intellectually realistic on both tasks, a large proportion (60%) of seven-year-olds were now consistently visually realistic on both tasks. Therefore there was still no significant discrepancy in performance between the cup and the ball tasks, and if anything this was even less evident than at Phase 1.

The seven-year-olds also showed higher levels of overall attention compared to the younger age groups, which again showed an improvement on Phase 1 performance. In particular they seem to have increased their looking 'within' drawing separate elements of the model, particularly when this was the cup model. However the majority of looking still occurred at the 'beginning' of the task before drawing commenced. This is consistent with this age group beginning to develop a more sophisticated attentional strategy that is dependent upon the particular demands of the task. The ball task did not require continued attention 'within' drawing separate elements of the model, because of its uniform shape. A cup can however vary quite considerably and the children who showed some awareness of the necessity of attending in order to accurately represent the model, should keep checking this model while they were drawing.

Consistent with this was the analysis comparing the looking behaviour of the visually and intellectually realistic drawers. The visually realistic drawers, as hypothesised, looked more than the intellectually realistic drawers but only with cup model, and in particular they looked more 'within' drawing separate elements of this model. Although there were no significant main effects of drawing realism for the ball model for either attentional measure, the Number of Looks did show how this interacted with look type. The visually realistic drawers showed higher levels of 'between' looking and were therefore adapting to the particular demands of the task i.e. two separate objects.

Similarly the extensive attentional strategy, which was consistent with high levels of 'within' and/or 'between' looking, was more common with the seven-year-olds and for the cup model. This age group did not display such strategic abilities with the ball model. This would again be consistent with the children adapting their behaviour to the particular task demands. This task required increased looking 'between' drawing separately elements, in order to accurately represent the back ball partially occluded by the front ball. The evidence however only showed a trend towards this and only with the visually realistic drawers. Therefore, as there were generally low numbers of visually realistic children in the sample as a whole, there was a general lack of subjects using the extensive strategies which resulted in a lack of difference between the three strategic categories. Therefore it seems that the ball task was not necessarily more difficult than the cup task, as concluded by Chen & Holman (1989), but that it placed differing drawing and attentional demands upon the child.

The children's adaptation to the particular demands of the two tasks, by changing their strategic attention, suggests they were possibly developing metacognitive awareness. This was shown by the increase in extensive awareness with age, although for this measure it was the ball task that led to the significant age differences. However inspection of the data in Table 9.11 shows that there were only slight variations in the number of children in each awareness category, between the cup and the ball tasks. Consistent with Phase 1, the ball model again led to the seven-year-olds showing higher levels of limited and extensive awareness, in comparison to the four- and five-year-olds. However the cup model seems to have led to reduced levels of extensive awareness in comparison to Phase 1, particularly for the seven-year-olds. Therefore although they were using a more sophisticated strategy, they did not show high levels of awareness as a group. However this particular strategy could be quite subtle and performed without much conscious awareness of it.

In Phase 1 assessment of the relationship between drawing performance, strategy use and metacognitive awareness, showed that the four-year-olds' strategic attentional abilities positively correlated with drawing performance, the five-year-olds drawing performance related to increased awareness for the ball task, and reduced awareness for the cup task, and the six-year-olds showed associations between increased strategy use and increased awareness. In Phase 2, the four-year-olds showed the associations evident in the five-year-olds at the first phase of assessment, even though this age group were still six months younger than the five-year-olds had been at Phase 1. The majority of the four-year-olds (79% on the cup task and 86% on the ball task) were intellectually realistic, and had either no or limited awareness of the effective attentional strategy. However for the cup task a further 21% were visually realistic and had no awareness, therefore resulting in the negative direction of this association (for the five-year-olds at Phase 1 these percentages were very similar i.e. 60%, 70% and 15% respectively). This age group now showed relationships between performance and awareness where as at Phase 1 they had shown no correspondence between the awareness and either the performance or strategy measures.

The five-year-olds showed strong associations between all measures, therefore unlike their own, or the six-year-olds performance at Phase 1. However the age gap between the middle and oldest age groups, meant that the five-year-olds were presently sixteen months younger than the oldest age group had been at Phase 1. The majority of children on both tasks were intellectually realistic, non-strategic, and had limited awareness, however a few individuals were visually realistic and showed either limited or extensive strategic abilities and awareness. Therefore even though there were generally low levels of performance, strategy use and awareness for this age group, there were a few subjects who showed corresponding increases in performance, strategy use and awareness.

Unlike Phase 1, the seven-year-olds were now showing associations between drawing performance and strategy use, but only for the cup model. This reflects the results discussed above, in that the cup model led to increased strategic attention. The majority of this age group used an extensive strategy and produced a visually realistic drawing.

Therefore the drawing performance of this age group was now benefiting from the use of the attentional strategies.

Phase 1 showed consistent positive associations between the child's response to whether they thought they could still draw the model if it was hidden from view, and awareness of why this was the case. However the association between these two measures for the five-year-olds with the ball model, and the seven-year-olds with the cup model could not be computed due to the whole sample stating that they would still be able to draw it. Although this pattern was evident for the five- and seven-year-old associations that could be computed, the number of subjects responding with "no" was still low. Therefore the increase in subjects producing this response and having extensive awareness of the necessity to attend to the model while they drew, did not as was hoped, occur. The four-year-olds showed the opposite pattern in that answering "yes" was generally associated with limited awareness, while answering "no" was associated with non-awareness. Therefore having awareness of the necessity to attend to the drawing model while drawing, does not necessarily follow a "no" response i.e. the child still thinks they will be able to draw it. It is possible that confidence in their own abilities overrides their understanding of this strategy, with this original metacognitive question.

The results of the drawing task therefore show that the seven-year-olds drawing ability was superior to the four- and five-year-olds. This seems to be due to the use of more sophisticated attentional strategies, which reflect the particular demands of the drawing model. However overall awareness of these strategies still seem to be relatively low, particularly for the cup model. The four-year-olds did however show increased awareness and an association between this and drawing performance. They were showing equivalent abilities to the five-year-olds at Phase 1. The five-year-old age group for this present phase, showed strong associations between performance, strategy use and awareness, and therefore seem to have progressed from the transitional phase reported in Phase 1. The six-year-olds had also developed between the two testing phases in that they now seemed to be showing increased benefits from their use of effective attentional strategies.

9.3.2 MEMORY TASK

The seven-year-olds showed superior memory recall ability compared to the other two age groups. This was therefore different to Phase 1 where the five-year-olds were also recalling significantly more cards than the four-year-olds. Therefore the seven-year-olds performance seems to have increased at an accelerated rate. Memory ability increases dramatically with age, and due to the age gap between the five- and seven-year-old age groups, it is possible that this group would begin to show greater increases in performance on this task. However the grouped display type did maintain its beneficial effect on performance, and again only with the older age group. Therefore it is possible that the four- and five-year-olds performance was being hindered because they were still not benefiting from the clustering strategy, whereas the seven-year-olds accelerated performance was the result of *increased* benefit from this.

These age differences were reflected in the clustering categories, in that although the mixed display type showed no differences between categories and ages, the seven-year-olds showed higher levels of limited and extensive clustering compared to the five-year-olds, for the grouped display type. However the ARC clustering scores did show a significant improvement with the grouped display type across all three ages. Therefore even the four-year-olds were using the prompt given by this condition to increase clustering at recall, however this was not reflected in significant increases in performance levels. These results therefore agree with the findings of Baker-Ward, Ornstein & Holden (1984). However it is possible that their recall just reflects the order with which they encoded the items and not a conscious strategy to use clustering to aid recall.

Dividing the children into the different clustering categories did not reveal any significant differences in recall performance. However the previous results suggest that the seven-year-olds would show increased recall with the use of the limited or extensive clustering strategies, for the grouped display type. However it was not possible to include age as a factor in this analysis, due to no five- and seven-year-olds falling into the non-strategic category. Therefore the interaction between category and age on recall performance could not be investigated.

There were improvements in performance on the metacognitive awareness questions between the two testing phases. More five-year-olds were able to accurately judge that the grouped arrangement of cards would lead to increased performance (61% at Phase 2 compared to 45% at Phase 1). This age group therefore showed no difference in performance on this question, in comparison to the seven-year-olds. Accurate justifications of why the chosen arrangement would aid recall also increased between phases. At Phase 1, 100% of the four-year-olds showed no awareness of the clustering mnemonic, while 14% now showed some limited awareness. Both the seven- and five-year-olds showed increased levels of extensive awareness (33% as opposed to 5%, and 73% as opposed to 50%, for the five- and seven-year-olds respectively). These results were therefore consistent with Schneider & Sodian (1988), and Sodian, Schneider & Perlmutter (1986), in that the four-year-olds showed some awareness, and that this increases with subsequent age.

Unlike Phase 1 the four-year-olds did not show an association between recall and strategy use, these results therefore now agreed with those reported by Sodian *et al.* (1986). In fact this age group only showed one significant effect in that recall for the mixed display type was related with the mix/group arrangement choice. In general the majority of the children were unable to choose either, as they did not understand the task. However those few children who did select the mixed and the grouped arrangement, showed increasing recall ability. This was not the case with the grouped display type where these subjects recall was poor. Therefore it seems that although these children were showing some understanding of the metacognitive task by actually giving a choice of arrangement, this did not generally reflect performance levels, and these subjects showed little understanding of why the chosen arrangement would aid recall.

The five-year-olds showed no associations between performance, strategy use and metacognitive awareness. This was generally consistent with Phase 1, in that this age group showed quite diverse behaviour patterns across all levels of the three measures. They did however show a positive association between the two metacognitive questions, in that selecting the grouped arrangement was associated with extensive awareness of how this would aid recall, while incorrectly selecting the mixed arrangement was associated with reduced awareness. This is consistent with the results discussed earlier in that, awareness of the clustering strategy in this age group had increased, even though performance levels do not seem to show any corresponding increase between the two phases. Therefore these children were not as yet benefiting from this advanced awareness, but it is possible that this will develop at the next testing phase. These results were different to Schneider & Sodian (1988) and Henry & Norman (in press) where they reported a relationship between performance and awareness in children ranging from four to six years of age. However the memory and metacognitive tasks did vary between these two and the present study.

The seven-year-olds showed a significant correlation between increased recall and awareness of the effectiveness of the clustering strategy, but only for the mixed display type. In order to be strategic on this task, the child needs to either spontaneously understand the necessity of rearranging the cards internally into their conceptual categories at encoding, or to transfer this ability from the previous task, depending on the order of presentation of the mixed and grouped display types. Either of these require extensive awareness of how this mnemonic can aid recall, and therefore possibly led to the association between recall and awareness. With the grouped display type, which provides the prompt to use this strategy anyway, there is less demands on the child's own awareness and therefore no association between performance and awareness. However this age group did show an association between strategy use and awareness for the grouped display type. Prompting the child led to an increase in strategy use and may subsequently have led to a realisation that this can aid recall. Therefore to perform well with the mixed display type awareness is necessary to begin with, while this may develop through actually performing the task with the grouped display type.

The results of the memory task show, like the drawing task, that the seven-year-olds were showing superior performance to the other two age groups. They were benefiting from the grouped display type prompting strategy use. While the younger age groups did respond to this prompt by increasing their clustering of items at recall, this was not as yet reflected in their performance levels. However awareness of the clustering strategy showed increases, in comparison to Phase 1, particularly for the five-year-olds, and therefore it is hoped that this age group would show these benefits at the next phase of assessment.

9.3.3 SELECTIVE ATTENTION TASK

The children's overall performance on the selective attention task reflected performance on the other two tasks and Phase 1, in that the seven-year-olds showed superior accuracy at differentiating the house pairs than the other two age groups. With regard to the separate house pairs, all age groups were able to make an accurate judgement when the houses were the same, the four-year-olds could accurately judge dissimilarity when there were two differences, and the five-year-olds with only one difference. However it was not until seven years of age that the children could accurately judge dissimilarity when the spatial locations of the pictures were changed. All three age groups showed improvements in performance, in comparison to Phase 1, with the four-year-olds now judging dissimilarity with two differences, the five-year-olds with one difference and the seven-year-olds with changed locations. Therefore the older age group seems to have understood the necessity of the homologous windows being identical for the house pairs to be the same. These results therefore reflect those of Vurpillot (1968) in that increasing the number of differences aids the performance of the younger age groups. However they still do not reflect Vurpillot's findings of children terminating their search when a difference had been found, and in fact the tendency not to look at all the windows reduced between phases. Ninety-one percent of subjects opened all the windows at Phase 2, as opposed to 84% at Phase 1.

Strategic search behaviour was shown to increase with age, in that 0% of four-year-olds, 40% of five-year-olds and 58% of seven-year-olds were extensively strategic.

Therefore in total 34% of subjects were extensively strategic, 47% were limited and 19% were non-strategic. The majority of the extensive group (77%) opened homologous windows while the remaining 23% opened all the windows in one house, then all the windows in the second, but scanned back to the homologous picture pair as they did so (doing this without scanning back accounted for the majority of children in the limited strategy group). The children that did use these exhaustive strategies were subsequently more accurate in differentiating the house pairs. These results are in agreement with Phase 1 and with Vurpillot's findings of increasing strategy use with age. However, in agreement with Day & Bissell (1978), the majority of four-year-olds (84%) used limited opening strategies and could not therefore be classified as non-systematic in their behaviour.

The children were classified into three categories of metacognitive awareness on the basis of their justifications of why they thought the house pairs were the same or different. The four-year-olds did not seem to have any awareness of the necessity to compare the matching pictures across the pair of houses, although for Pair 4 they showed no significant difference in performance compared to the other two age groups. However, although they seem to have performed well with what has been shown to be the most difficult pair of houses, the actual numbers of subjects in the extensive awareness category did not vary to any great extent between the four different pairs. The five-year-olds showed high levels of extensive awareness with Pairs 3 and 4, therefore it seems that the increase in the number of differences not only aided their accuracy at differentiating the houses, but also their ability to justify their judgement. However it was the seven-year-olds who showed consistent extensive awareness across the four house pairs, which was consistent with their performance at Phase 1.

Day & Bissell (1978) found that two thirds of their four-year-olds used justifications that were different to those considered appropriate by an adult. As discussed in Phase 1, these would seem to be consistent with the limited awareness category for the present study. However at Phase 1 only 20% of this age group showed this level of awareness, although they were younger than Day & Bissell's subjects. At phase 2 these subjects were the same age (range 4:3 to 4:9 in the present study and 4:2 to 4:11 in Day & Bissell's) yet there were still few subjects in the limited awareness category i.e. only 23%. However closer inspection of Day & Bissell's descriptions of justifications revealed that not all of these actually reflected the justifications classified as limited awareness in the present study. Therefore there were in fact only 34% of Day & Bissell's subjects that gave equivalent responses, a percentage which is fairly similar to the results of the present study.

With regard to the associations between measures, the four-year-olds showed no associations between the same/difference judgement and their opening strategy. This was therefore unlike their performance at Phase 1. They did however show associations between the same/difference judgement and awareness of this, for Pairs 1 and 3. An accurate judgement was associated with extensive awareness of why this was the case, while an inaccurate judgement was associated with no awareness. Pairs 1 and 3 were relatively easy to differentiate for this age group even at Phase 1, therefore by this phase they were showing an accomplished ability to both differentiate and justify their decisions. A lack of awareness was also associated with being non-strategic, while extensive awareness was generally associated with the use of limited strategies, across all house pairs. Those children who systematically opened the windows in one house and then in the other, even without scanning back to the homologous pairs, were better able to justify their decisions, than those children who searched more randomly.

With age there was an increasing ability to use exhaustive window opening strategies, which subsequently led to more accurate judgements of the similarity/dissimilarity of the house pairs, and an increasing awareness of the necessity to compare homologous windows in order to justify these judgements. Consistent with Phase 1, the five-year-olds showed how an increased ability to differentiate house pairs was associated with an increased ability to justify these judgements. However they also showed how an accurate judgement was associated with exhaustive strategy use, but only for Pair 3. This age group found this pair relatively easy to differentiate even at Phase 1, and therefore this ability was well established by the second phase, and therefore showed an association between using an exhaustive strategy and differentiating the pair.

Equivalent to Phase 1, the seven-year-olds showed associations between extensive awareness and both accurate judgement and exhaustive strategy use. However they had improved on Phase 1 by also showing associations between the latter two measures. They therefore showed strong associations between all three measures. Therefore the use of an exhaustive window opening strategy led to an increased ability to differentiate house pairs, and a subsequent increase in awareness of the necessity to compare homologous windows in order to justify their judgement.

The results of the selective attention task therefore reflect those of the other two tasks, in that the seven-year-olds showed superior ability to accurately differentiate house pairs, although the performance levels of the younger two age groups did vary with the differing demands of the four house pairs. This ability was also affected by strategy use, in that the use of a limited opening strategy for the four-year-olds and an exhaustive strategy for the five- and seven-year-olds led to an increased ability to differentiate house pairs, and increased awareness of how to justify these judgements. These associations are beginning to develop in the younger two age groups and vary with particular demands of the tasks, however the seven-year-olds showed more consistent associations across pairs.

9.3.4 TASK EFFECTS

Comparison of performance within each of the three tasks showed fairly similar results, in that the seven-year-olds were more visually realistic, recalled more items and more accurately judged the similarity/dissimilarity of the house pairs, than the younger age groups. Direct comparison between the tasks themselves revealed that the children's performance levels were not comparable, except for the four- and seven-year-olds who showed that increased drawing realism on the ball and the cup tasks respectively, was related to an increased ability to differentiate house pairs.

Unlike performance levels, strategic abilities seem to be fairly consistent across the tasks except where the children were affected by the task demands. In particular the four- and seven-year-olds were affected by the display type presented to them in the memory task. Prompting the four-year-olds to the mnemonic strategy led to increases in strategic ability, in comparison to their strategy use in the drawing task which did not provide any prompt, as only standard instructions were presented to the children. Not providing the prompt for the seven-year-olds in the memory task, and relying on either spontaneous ability or the ability to transfer the strategy used from the grouped display type (depending on the order of presentation of the tasks), led to reductions in strategic ability in relation to the selective attention task. This age group's ability to be strategic on the selective attention task was by this phase well developed, and they did not show the reduced levels of strategy use in the drawing task displayed by the four-year-olds, because they had reached an age where they do not require instructions to prompt them to use an effective attentional strategy.

The generally high levels of metacognitive awareness in the selective attention task for the five- and seven-year-olds were also evident with the analysis which compared abilities across tasks. Both these age groups showed how this was greater than their awareness on the drawing tasks. The children did not necessarily have to give a verbal response to the metacognitive question in the selective attention task, in that they could just point to the similarities or differences between house pairs. These age groups were also showing increasing strategic abilities which were reflected in an increased ability to justify their decisions. However, due to subtly of the attentional strategy in the drawing task, in comparison to the window opening strategy, it is possible that children were being strategic without conscious awareness of this. The metacognitive questions for the drawing task also required a verbal response which has been shown to be problematic in young children (Henry & Norman, in press). Therefore these factors could have contributed to the discrepancy between awareness on these two tasks.

9.3.5 CONCLUSIONS

Therefore the evidence seems to support the view reported in Phase 1, that children develop a general strategic ability or understanding that filters through to all tasks, and therefore that strategic abilities on different cognitive tasks do not develop at different ages. However this general ability is affected by the demands of the task, for these young age groups at least. The four-year-olds were beginning to respond to prompts to use more sophisticated strategies, while although the seven-year-olds were performing well without the prompt, when they were presented in the memory task they showed accelerated performance.

The children were however still performing differently on the three tasks and therefore despite consistent strategic abilities these do not generally translate into consistent performance levels within the individual, possibly due to lack of experience or knowledge of the particular tasks. It was hoped that if this was the case that the older age group would show an increased number of correlations at this phase. However this was not evident and in fact it was the four-year-olds who showed corresponding performance between the drawing and the selective attention tasks. Unlike Phase 1, assessment of awareness now showed variations across tasks which seem to reflect the particular demands of the different tasks. Therefore consistent with previous research, even the younger children showed some awareness of efficient strategies in different tasks, which gradually begins to translate into the use of strategies and increases in performance levels.

Since Phase 1 the children have demonstrated a developing ability to perform well, use strategies and show metacognitive awareness of these strategies, with these abilities being increasing associated with each other. This pattern was particularly evident with the seven-year-olds, who were showing increasing benefits from the use of sophisticated strategies across the three tasks. The younger age groups were beginning to develop awareness of these strategies and hopefully this will reflect in increased strategy use and performance at the next phase of assessment.

CHAPTER 10

LONGITUDINAL STUDY PHASE 3

10.1 METHOD

10.1.1 SUBJECTS

Out of the forty-seven children remaining at Phase 2, forty-three were available at the third phase of assessment. There were twelve children in the youngest age group which had a mean age of 4 years 11 months (range 4:9 to 5:2, standard deviation 0:2 months). The middle age group consisted of seventeen children with a mean age of 6 years one month (range 5:10 to 6:4, standard deviation 0:2 months), and the oldest age group had fourteen children remaining with a mean age of 7 years 11 months (range 7:8 to 8:2, standard deviation 0:2 months). These age groups will subsequently be referred to as five-, six- and seven-year-olds. There were twenty-two males and twenty-one females in total. There were six males and six females in the five-year-old age group, nine males and eight females in the six-year-old age group, and seven males and seven females in the seven-year-old age group.

10.1.2 ATTRITION

In order to determine whether the children who were not available for testing at the third phase were significantly different from the children who remained, their performance at Phase 2 was compared.

Drawing Task

There was no significant difference between the two subject groups with regard to the proportion of intellectually and visually realistic drawers, for both models (Fisher Exact Test $p>.05$). However it must be noted that the one seven-year-old who was unavailable was intellectually realistic at Phase 2 and therefore this has added to the problem highlighted at Phase 2, in that there were disproportionate more visually realistic children in this older age group.

There was no significant difference between the two subject groups with regard to either their number of looks or looking time ($F(1,41)=0.01$ and 0.06 $ps>.05$ respectively). There were also no significant interactions between attrition and age ($F(2,41)=0.14$ and 0.02 $ps>.05$ respectively). There were no significant differences regarding classification of the children's attention into strategic categories, for both tasks (Fisher Exact Test $ps>.05$). With regard to classification of the children's awareness of the attentional strategy, there were disproportionately more children, across ages, classified as having no awareness who were unavailable at Phase 3 (Fisher Exact Test $ps<.05$).

Memory Task

There was no significant difference between the two subject groups with regard to either their memory recall scores or their ARC clustering scores ($F(1,41)=0.37$ and $F(1,31)=0.14$ $ps>.05$ respectively), or an interaction between attrition and age for recall ($F(2,41)=0.20$ $p>.05$). This interaction could not be computed for the ARC scores due to the one non-remaining five-year-old having an undefined ARC score. There were no significant differences regarding classification of strategic behaviour or awareness of the clustering strategy, for either the grouped or the mixed display type (Fisher Exact Test $ps>.05$).

Selective Attention Task

There was no significant difference between the two subject groups with regard to their total number of accurate same/different judgements across house pairs ($F(1,41)=2.31$ $p>.05$), or an interaction between attrition and age ($F(2,41)=0.09$ $p>.05$). There were no significant differences regarding classification of the most predominant window opening strategy, or classification of the most predominant awareness category across house pairs (Fisher Exact Test $ps>.05$).

There were therefore no significant differences (except for a disproportionate loss of children having no awareness of the attentional strategy in the drawing task) between the children who remained at Phase 3 and those who were unavailable, with regard to their performance at Phase 2. However the loss of another intellectually realistic seven-year-old could add to the problems highlighted in the Method section of Phase 2 (Section 9.1.3).

10.1.3 SCORING RELIABILITY

Ten percent of the original sample size were randomly selected and their data re-scored at each of the three phases. Therefore only those subjects for whom data was available at all three phases were included. The reliability of the video data was conducted on an intra-observer basis due to the scoring procedures being lengthy and complex. The classifications of the first judge/assessment were used in the analyses.

Drawing Data

In order to establish inter-judge reliability the children's drawings were re-classified by a second independent judge. Classification showed a 100% agreement. The Kappa statistic [for assessment of categorical data (Siegel & Castellan, 1988)] showed perfect agreement between judges which was found to be significantly different from zero ($K=1.00$, $Z=9.68$ $p<.001$).

Pearson Product Moment correlations were used to compare the relationship between the first and second assessments of attention paid towards the model, separately for each measure. There were a high number of zero scores due to many subjects only looking at the 'beginning' of the task. It was felt that inclusion of these scores would adversely affect the analyses. The correlation on the remaining data showed strong relationships for both the Number of Looks and Looking Time measures ($r=0.90$ and 0.99 respectively, $d.f.=62$, $ps<.001$).

Due to the zero scores being omitted from the correlation, intra-observer reliability of classification of attention into the four look types was assessed using the Phi Coefficient [for use with nominal data (Siegel & Castellan, 1988)]. There was a 100% agreement overall, which represented perfect associations of $r_ø=1.00$ for each of the four look types, with these scores being significantly different from zero (X^2 = 9.00, 31.44, 31.44 and 29.14 $d.f.=1$ $ps<.001$).

With regard to classification of the children's attention into the three strategic categories, there was an 89% agreement ($K=0.82$, $Z=4.74$ $p<.001$). Re-classification of the meta-awareness questions showed a 100% agreement for the question of whether the child thought they could still produce the drawing or not, and 97% agreement for the classification of their justifications of this response ($K=1.00$ and 0.95, $Z=5.52$ and 4.26 respectively $ps<.001$).

Memory Data

There was a 100% agreement with regard to which cards were recalled. Pearson product moment correlations were used to compare the relationship between the first and second assessments of the number of cards recalled either correctly, as repetitions, as intrusions or incorrectly. This showed a very strong relationship of $r=0.99$ (d.f.=42 $p<.001$). There was a 100% agreement of the clustering sequence of the cards recalled ($K=1.00$, $Z=4.24$ $p<.001$), a 94% agreement between the ARC clustering scores ($r=0.99$ d.f.=34 $p<.001$), and a 94% agreement between classification of these scores into the three clustering categories ($K=0.91$, $Z=6.64$ $p<.001$). With regard to the meta-memory questions, there was a 94% agreement of whether the child selected the Mixed or Grouped arrangement as aiding their recall, or neither of these, and a 100% agreement between classification of their justifications of this choice ($K=0.89$ and 1.00, $Z=2.65$ $p<.01$ and $Z=6.09$ $p<.001$ respectively).

Selective Attention Data

There was a 100% agreement between whether the child judged that the two houses were the same or different ($K=1.00$, $Z=17.16$ $p<.001$). There was an 89% agreement between assessments of the sequence with which the children opened the windows, with the majority of differences being homologous pair reversals. There was a 90% agreement between classifications of these sequences into the three opening strategies ($K=0.79$, $Z=5.19$ $p<.001$), and finally a 93% agreement between justification categories ($K=0.88$, $Z=6.27$ $p<.001$).

The remaining sections were identical to Phase 1.

10.2 RESULTS

The following sections detail the main findings of the analyses. The full analysis of variance summary tables and details of the subsidiary results are given in Appendix N.

10.2.1 DRAWING TASK

10.2.1.1 DRAWING DATA

The number of children in each age group producing the different categories of drawings in response to the two models are detailed in Table 10.1.

Cup Drawing

Chi-Square tests showed that a greater proportion of seven-year-olds produced visually realistic drawings than both the five- and six-year-olds ($ps<.01$), with the latter two age groups not being significantly different from each other (Fisher Exact Test $p>.05$). These age effects were therefore comparable to Phase 2.

Ball Drawing

Like the cup drawings, a greater proportion of seven-year-olds produced visually realistic drawings than both the five- and six-year-olds (Fisher Exact Test $ps<.01$), with the latter two age groups again not being significantly different from each other (Fisher Exact Test $p>.05$). The results for this task were therefore equivalent to performance at Phases 1 and 2.

Comparison Across Tasks

A Phi correlation coefficient was calculated in order to compare the relationship between a child being classified as either intellectually or visually realistic on each of the two tasks. This correlation was significant ($r\phi=0.85$ d.f.=41 $p<.001$), in that most children showed comparable performance on both tasks. Fisher tests also confirmed this pattern of results overall combining all ages ($p<.001$). Fisher tests for the individual ages revealed that the five- and six-year-olds showed no significant differences across tasks

TABLE 10.1 FREQUENCY OF DRAWINGS FOR EACH MODEL

	CUP DRAWING			BALL DRAWING			
Age	Visually Realistic	Intellec-tually Realistic	Scr-ibble	Visually Realistic	Intellec-tually Realistic	Omis-sion	Scr-ibble
5	1	10	1	0	12	0	0
6	1	16	0	1	16	0	0
7	11	3	0	10	4	0	0

(ps>.05). Inspection of the data in Table 10.2 shows that the majority of these children were intellectually realistic on both tasks, however the seven-year-olds were visually realistic on both tasks (Fisher Exact Test p<.05), therefore equivalent to Phase 2.

10.2.1.2 ATTENTIONAL DATA

10.2.1.2.1 Number of Looks

A 3 (age) x 2 (gender) x 2 (drawing order) x 2 (drawing model) x 4 (look type) analysis of variance was performed on the number of times each child looked at the model in front of them. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

Unlike Phase 2 but equivalent to Phase 1, the ANOVA showed no significant main effect of age (F(2,31)=2.25 p>.05). There were also no significant main effects of drawing order or drawing model (ps>.05), however these two factors did significantly interact with each other (F(1,31)=8.70 p<.01). Scheffe's method of follow-up analysis revealed a significant reduction in attention from the first to the second model but only with the cup/ball order (Scheffe F(1,31)=13.35 p<.05). As detailed in Table 10.3, the cup model showed high levels of attention when presented first.

The ANOVA also showed a highly significant main effect of look type (F(2,72)=84.47 p<.001*), in that significantly more looks occurred at the 'beginning' of the task compared to all other look types (Scheffe ps<.001). Unlike Phase 1, there was no additional significant difference between the 'within' and 'between' look types. However look type did significantly interact with drawing model and drawing order (F(3,83)=3.67 p<.05*). Follow-up analysis revealed that the 'within' looks were high for the cup model as these were not significantly different from the 'beginning' looks, whereas these two look types were not significantly different for the ball model. Although this pattern of results was evident for both drawing orders, the 'within' looking was particularly high when the cup was presented first. See Table 10.4 for details of the means and Figure 10.1 for an illustration of this effect.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 10.2 COMPARISON OF PERFORMANCE ACROSS DRAWING TASKS

	BALL VISUAL REALISM (V.R.)		BALL INTELLECTUAL REALISM (I.R.)	
AGE	CUP V.R.	CUP I.R.	CUP V.R.	CUP I.R.
5	0	0	1	10
6	1	0	0	16
7	10	0	1	3
TOTAL	11	0	2	29

TABLE 10.3 MEAN NUMBER OF LOOKS PER DRAWING ORDER AND DRAWING MODEL

DRAWING MODEL / DRAWING ORDER	BALL	CUP	MEAN TOTAL
BALL/CUP	0.16 (0.63)	0.15 (0.51)	**0.15 (0.57)**
CUP/BALL	0.13 (0.48)	0.19 (0.83)	**0.16 (0.65)**
MEAN TOTAL	**0.15 (0.55)**	**0.17 (0.67)**	

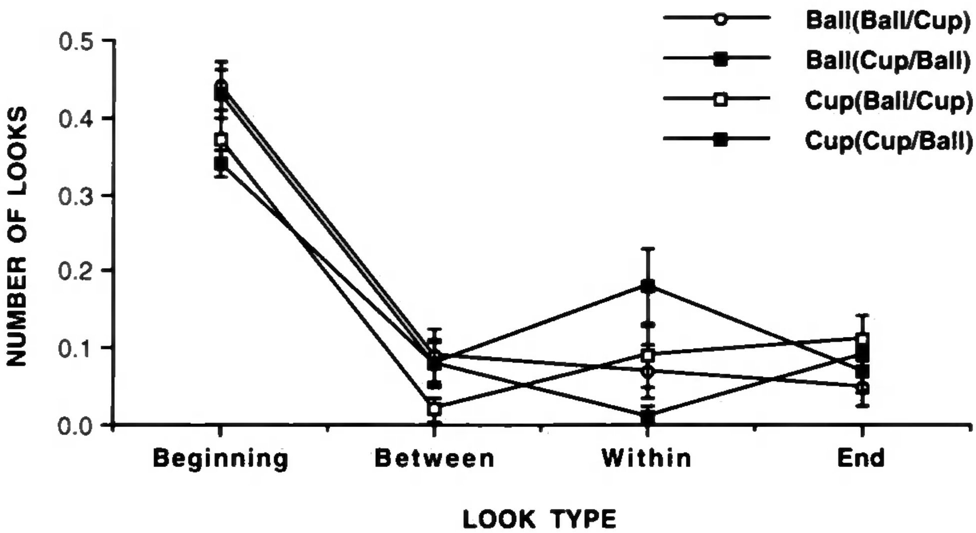
Untransformed means (number of looks) are shown in parentheses.

TABLE 10.4 MEAN NUMBER OF LOOKS PER LOOK TYPE, DRAWING MODEL AND DRAWING ORDER

DRAWING MODEL	DRAWING ORDER	BEGINNING	BETWEEN	WITHIN	END
BALL	BALL/CUP	0.44 (1.87)	0.09 (0.26)	0.07 (0.21)	0.05 (0.18)
	CUP/BALL	0.34 (1.28)	0.08 (0.33)	0.01 (0.03)	0.09 (0.28)
CUP	BALL/CUP	0.37 (1.35)	0.02 (0.04)	0.09 (0.29)	0.11 (0.35)
	CUP/BALL	0.43 (1.98)	0.08 (0.23)	0.18 (0.84)	0.07 (0.26)
MEAN TOTAL		**0.39 (1.62)**	**0.07 (0.21)**	**0.09 (0.35)**	**0.08 (0.27)**

Untransformed means (number of looks) are shown in parentheses.

FIGURE 10.1 INTERACTION OF DRAWING ORDER BY DRAWING MODEL BY LOOK TYPE FOR NUMBER OF LOOKS MEASURE



Number of Looks and Drawing Realism

A two-way 3 (age) x 2 (drawing realism), and a one-way 2 (drawing realism) analysis of variance for the cup and the ball tasks respectively, were performed in order to compare the number of looks of the visually and intellectually realistic drawers. The factor of age could not be included for the ball task due to no five-year-olds producing a visually realistic drawing. Due to unequal variances and the standard deviations being proportional to the means, log(10) transformations were performed on the data.

For both the cup and the ball models, the ANOVA showed no significant main effect of drawing realism ($F(1,36)=1.09$ and $F(1,41)=3.10$ $ps>.05$). However the means were in the hypothesised direction in that the visually realistic drawers looked at the model more times than the intellectually realistic drawers (mean number of looks = 0.85 and 0.59 for the cup model and 0.68 and 0.51 for the ball model, respectively). There were also no interactions between drawing realism and look type ($ps>.05$).

10.2.1.2.2 Looking Time

A 3 (age) x 2 (gender) x 2 (drawing order) x 2 (drawing model) x 4 (look type) analysis of variance was performed on the time each child spent looking at the model in front of them. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

Unlike the results for the Number of Looks measure, this ANOVA showed a significant main effect of age ($F(2,31)=4.55$ $p<.05$). Follow-up analysis showed that the seven-year-olds paid more attention to the model than the six-year-olds (mean seconds = 1.03, 0.65 and 0.77 for the 7-, 6- and 5-year-olds respectively). Therefore, although each age group looked at the model the same number of times, the duration of these looks varied between the age groups.

There were no significant main effects of drawing order or drawing model ($ps>.05$), however these two factors did significantly interact with each other ($F(1,31)=6.34$

$p<.05$). Follow-up analysis however revealed no significant differences between the individual means. However, the cup model showed high levels of attention, particularly if this was presented first. This trend therefore reflected the significant results observed with the Number of Looks measure. See Table 10.5 for details of these means.

The ANOVA also showed a highly significant main effect of look type ($F(3,84)=219.78$ $p<.001$*), and an interaction between look type and drawing model ($F(3,87)=4.65$ $p<.01$*). Follow-up analysis revealed that significantly more time was spent looking at the 'beginning' of the task compared to all other look types ($ps<.01$). However, as shown in Table 10.6 and illustrated in Figure 10.2, the cup drawing led to significantly higher 'within' looking than the ball drawing (Scheffe $F(3,87)=19.86$ $p<.05$*).

Looking Time and Drawing Realism

A two-way 3 (age) x 2 (drawing realism), and a one-way 2 (drawing realism) analysis of variance for the cup and the ball tasks respectively, were performed in order to compare the looking time of the visually and intellectually realistic drawers. The factor of age could not be included for the ball task due to no five-year-olds producing a visually realistic drawing. Due to unequal variances and the standard deviations being proportional to the means, log(10) transformations were performed on the data.

For the cup model, the ANOVA showed a significant main effect of drawing realism ($F(1,36)=5.88$ $p<.05$), and a significant interaction between drawing realism and look type ($F(2,86)=3.13$ $p<.05$*). The visually realistic drawers spent more time looking at the model than the intellectually realistic drawers, but this effect was only evident with the 'beginning' look type. See Table 10.7 for details of the means and Figure 10.3 for an illustration of this effect.

The ANOVA for the ball model also showed a significant main effect of drawing realism ($F(1,41)=11.64$ $p<.01$), with the visually realistic drawers again spending more time looking at this model than the intellectually realistic drawers (mean seconds = 0.99 and

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 10.5 MEAN LOOKING TIME PER DRAWING ORDER AND DRAWING MODEL

DRAWING MODEL DRAWING ORDER	BALL	CUP	MEAN TOTAL
BALL/CUP	0.18 (0.84)	0.16 (0.61)	**0.17** **(0.72)**
CUP/BALL	0.15 (0.71)	0.21 (1.11)	**0.18** **(0.91)**
MEAN TOTAL	**0.17** **(0.77)**	**0.18** **(0.86)**	

Untransformed means (seconds) are shown in parentheses.

TABLE 10.6 MEAN LOOKING TIME PER LOOK TYPE, AND DRAWING MODEL

DRAWING MODEL	BEGINNING	BETWEEN	WITHIN	END
BALL	0.53 (2.71)	0.06 (0.19)	0.01 (0.06)	0.04 (0.12)
CUP	0.51 (2.54)	0.04 (0.11)	0.13 (0.57)	0.06 (0.23)
MEAN TOTAL	**0.52** **(2.63)**	**0.05** **(0.15)**	**0.08** **(0.32)**	**0.05** **(0.17)**

Untransformed means (seconds) are shown in parentheses.

TABLE 10.7 MEAN LOOKING TIME PER DRAWING REALISM AND LOOK TYPE (CUP TASK)

LOOK TYPE REALISM	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
Intellectual	29	0.46 (2.05)	0.08 (0.20)	0.09 (0.31)	0.05 (0.13)	**0.20** **(0.67)**
Visual	13	0.72 (3.60)	0.00 (0.00)	0.21 (1.02)	0.16 (0.24)	**0.27** **(1.22)**
MEAN TOTAL		**0.51** **(2.83)**	**0.04** **(0.10)**	**0.12** **(0.66)**	**0.05** **(0.18)**	

Untransformed means (seconds) are shown in parentheses.

FIGURE 10.2 **INTERACTION OF DRAWING MODEL BY LOOK TYPE FOR LOOKING TIME MEASURE**

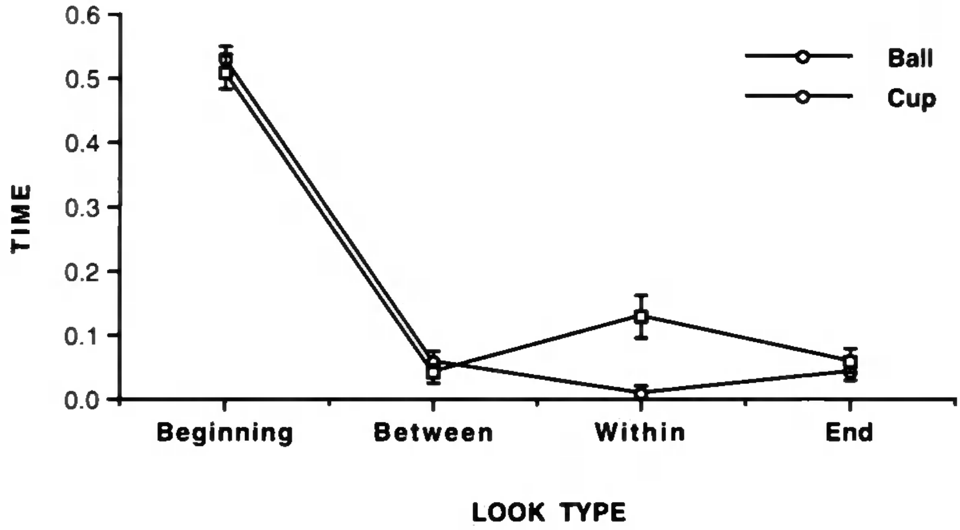
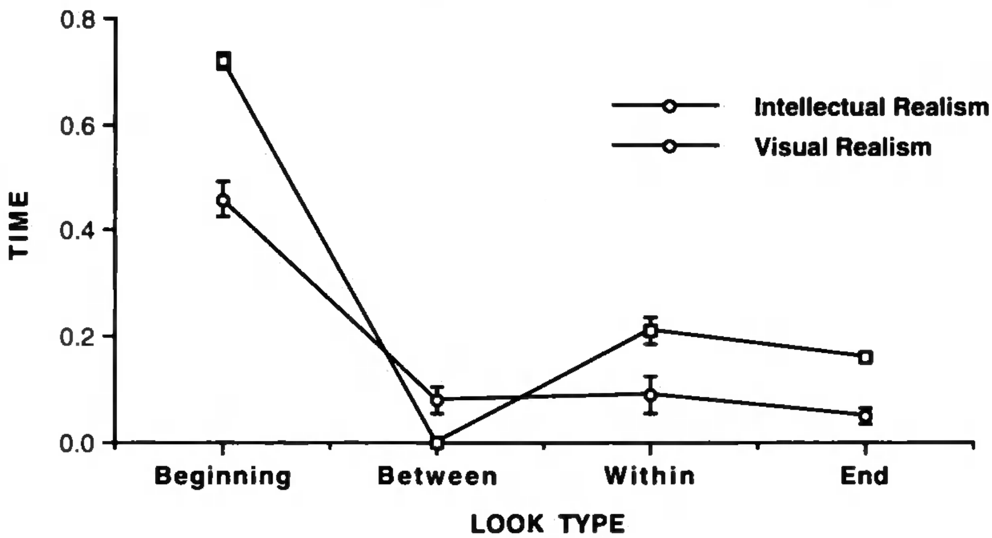


FIGURE 10.3 **CUP MODEL - INTERACTION OF DRAWING REALISM BY LOOK TYPE FOR LOOKING TIME MEASURE**



0.65 respectively). There was no significant interaction between look type and drawing realism ($F(3,105)=1.60$ $p>.05^{*}$).

Number of Looks and Looking Time

In order to assess the relationship between the two measures of attention, Pearson Product Moment partial correlations were performed on each child's total number of looks and looking time, separately for each task. Partial correlations were used in order to control for any possible age effects. These showed positive correlations of $r=0.56$ and 0.78 (d.f.=40 ps<.001) for the ball and cup tasks respectively.

10.2.1.3 STRATEGIES OF ATTENTION

Based on the children's strategic attention towards the drawing models, they were divided into three groups i.e. extensively strategic, limited strategic and non-strategic. Table 10.8 details the number of children in each category for each drawing model. There were no significant differences between the three categories and age groups, for either the ball or the cup models (Fisher Exact Test ps>.05). The children, in each age group, were therefore fairly evenly distributed across the three strategic categories.

10.2.1.4 META-AWARENESS QUESTIONS

Table 10.9 details the number of children, for each model and age group, responding either "yes" or "no" to the question of whether they thought they would be able to draw the model even if it was hidden from view. Goodness of Fit tests show all these differences to be significant (ps<.05). In total only 14% of children thought that they would not be able to draw, either or both, the cup and balls if they were hidden from view.

Table 10.10 details the number of children in each of the three awareness categories. These relate to the children's justifications of why they thought they would or would not still be able to draw the models. See Appendix J for full details of these three categories. There were no significant differences between the three categories and age groups, for either the ball or the cup task (Fisher Exact Test ps>.05). As shown in Table 10.10 the majority of children showed limited awareness of the strategy of attending to the model.

TABLE 10.8 STRATEGIC ATTENTIONAL CATEGORIES

CATEGORY AGE	EXTENSIVELY STRATEGIC	LIMITED STRATEGIC	NON-STRATEGIC	TOTAL
CUP				
5	5	2	5	12
6	5	3	9	17
7	8	2	4	14
TOTAL	18	7	18	
BALL				
5	2	4	6	12
6	4	4	9	17
7	7	2	5	14
TOTAL	13	10	20	

TABLE 10.9 YES/NO RESPONSES

		BALL		CUP	
AGE	N	YES	NO	YES	NO
5 YEARS	12	12	0	10	2
6 YEARS	17	16	1	16	1
7 YEARS	14	13	1	12	2
TOTAL		41	2	38	5

TABLE 10.10 META-AWARENESS CATEGORIES

CATEGORY AGE	EXTENSIVE AWARENESS	LIMITED AWARENESS	NO AWARENESS	TOTAL
CUP				
5	0	9	3	12
6	2	13	2	17
7	1	10	3	14
TOTAL	3	32	8	
BALL				
5	0	10	2	12
6	2	14	1	17
7	1	12	1	14
TOTAL	3	36	4	

10.2.1.5 ASSOCIATION BETWEEN MEASURES

In order to assess the relationship between the children's drawing performance, strategy use and metacognitive awareness of the attentional strategy, the Gamma statistic for ordinally scaled variables was used (Siegel & Castellan, 1988). Table 10.11 details these associations separately for each age group and both drawing models. In general, for the five-year-olds intellectual realism was associated with the use of a limited attentional strategy, and for the six-year-olds an extensive attentional strategy was associated with extensive awareness of necessity to attend to the drawing model.

More specifically, it was not possible to compute the majority of the associations for the five-year-olds for the ball model, due to the whole age group being intellectually realistic and responding "yes" to the original metacognitive question. For the cup drawing they showed significant negative associations between the "yes/no" response and both drawing realism and awareness of the extensive strategy of continued attention towards the drawing model ($ps<.05$). The majority of this age group (75%) were intellectually realistic and responded "yes" to the question of whether they though they would be able to draw the cup without it being in front of them, and had a limited awareness of the attentional strategy. One subject who answered "no" produced a scribbled drawing while the other was intellectually realistic, and both these children showed no awareness. Sixty-seven percent of this age group were intellectually realistic and used a limited attentional strategy ($G= +1.00$ $p<.05$).

For the cup task, the six-year-olds showed a significant association between strategic ability and awareness of this ($G= +0.56$ $p<.05$), in that increased strategy use related to increased awareness. For both drawing models they showed associations between the "yes/no" response and the other three measures ($ps<.05$). The majority of children answered "yes" and were intellectually realistic in their drawing ability (88%), showed all levels of strategic ability and had limited awareness. The one subject who believed that they would not be able to draw the model without it being in front of them was also intellectually realistic, but used an extensive attentional strategy and showed extensive awareness of why they thought they could still draw the model.

TABLE 10.11 GAMMA ASSOCIATIONS BETWEEN MEASURES

MEASURE AGE	DRAWING REALISM	ATTENTIONAL STRATEGY	YES/NO
CUP DRAWING			
5 YEARS			
ATTENTION	+0.00		
YES/NO	-1.00 *	+0.00	
AWARENESS	+1.00 *	-0.41	-1.00 *
6 YEARS			
ATTENTION	+0.29		
YES/NO	-1.00 *	+1.00 **	
AWARENESS	+0.00	+0.56 *	+1.00 **
7 YEARS			
ATTENTION	-0.11		
YES/NO	+1.00 *	-0.70 †	
AWARENESS	-0.50	+0.46	-1.00 *
BALL DRAWING			
5 YEARS			
ATTENTION	/		
YES/NO	/	/	
AWARENESS	/	-0.29	/
6 YEARS			
ATTENTION	+0.38		
YES/NO	-1.00 *	+1.00 **	
AWARENESS	-0.33	-0.23	+1.00 **
7 YEARS			
ATTENTION	+0.17		
YES/NO	+1.00 *	-0.17	
AWARENESS	+0.00	+0.00	+0.00

/ could not be computed because the whole sample were intellectually realistic and responded with "yes".

† $p=0.05$

* $p<0.05$

** $p<0.01$

The seven-year-olds showed a significant association between drawing realism and the "yes/no" response for both models ($G= +1.00$ $ps<.05$). The majority of children (64%) were visually realistic and responded with "yes". For the cup task alone, they showed significant negative associations between the "yes/no" response and both strategy use ($G= -0.70$ $ps=.05$) and awareness ($G= -1.00$ $p<.05$). Answering "yes" was associated with being extensively strategic, and with limited awareness, while the two children who answered "no" showed non- or limited strategy use and were both unaware of the attentional strategy.

Summary of Main Findings (Drawing Task)

1: The seven-year-olds produced more visually realistic drawings than the five- and six-year-olds, for both tasks. The majority of children showed comparable performance across the two tasks, with the five- and six-year-olds being intellectually realistic, and the seven-year-olds visually realistic on both tasks.

2: The seven-year-olds spent more time looking at the drawing model than the six-year-olds, with the majority of looking occurring at the 'beginning' of the task. However the cup model led to increased 'within' looking.

3: The visually realistic drawers spent more time looking at the models than the intellectually realistic drawers.

4: There was no developmental increase in the use of extensive strategic attention towards either model.

5: The majority of children showed only limited awareness of the strategic importance of attending to the models.

6: The majority of five-year-olds were intellectually realistic and used a limited attentional strategy, while the six-year-olds showed extensive strategy use and extensive awareness of these strategies. In opposition to the findings of the previous two phases, the five- and seven-year-olds showed how believing that they could not draw the model if it was hidden from view was associated with no awareness of the importance of attending to the model.

10.2.2 MEMORY TASK

10.2.2.1 RECALL RESPONSES

An initial one-way within subjects analysis of variance was performed in order to determine whether there was any significant difference between the children's recall responses with the two different sets of cards. Due to equal variances and a normal distribution, no transformation was necessary. The set of cards proved to be an insignificant factor ($F(1,42)=1.74$ $p>.05$). The mean recall score for the 'T' set was 6.33 (standard deviation 2.40) and for the 'H' set 5.72 (standard deviation 2.64), out of the possible twelve. The results were therefore pooled across the two sets of cards in the remaining analyses.

A 3 (age) x 2 (gender) x 2 (presentation order) x 2 (display type) analysis of variance was performed on each child's recall scores. Due to unequal variances and a narrow range of scores, the number of correctly recalled cards was divided by the total number possible i.e. twelve, and an arcsine transformation performed on this proportional score. This revealed a significant main effect of age ($F(2,31)=6.01$ $p<.01$), in that the 7-year-olds recalled more items than both the 5- and 6-year-olds (Scheffe $ps<.05$). See Table 10.12 for details of these means.

The ANOVA also showed a main effect of display type ($F(1,31)=7.24$ $p<.05$), in that the grouped display type led to significantly more pictures being recalled than the mixed display type. This factor also interacted with age ($F(2,31)=4.41$ $p<.05$) revealing that this pattern of results was only significant for the 7-year-olds (Scheffe $F(2,31)=17.17$ $p<.05$), while the 5- and 6-year-olds showed no significant difference between the two display types (Scheffe $ps>.05$). This effect is detailed in Table 10.12 and illustrated in Figure 10.4. Unlike Phase 2 and similar to the results of Phase 1, there was an interaction between display type and presentation order ($F(1,31)=6.28$ $p<.05$). Follow-up analysis revealed that there was a reduction in recall ability for the mixed display type when this was presented second. These means are detailed in Table 10.13.

TABLE 10.12 MEAN RECALL SCORES PER DISPLAY TYPE AND AGE

AGE	N	MIXED	GROUPED	MEAN TOTAL
5 YEARS	12	0.45 (5.13)	0.47 (5.32)	**0.46 (5.22)**
6 YEARS	17	0.48 (5.54)	0.51 (5.57)	**0.50 (5.55)**
7 YEARS	14	0.55 (6.00)	0.83 (8.64)	**0.69 (7.32)**
MEAN TOTAL		**0.49 (5.55)**	**0.60 (6.51)**	

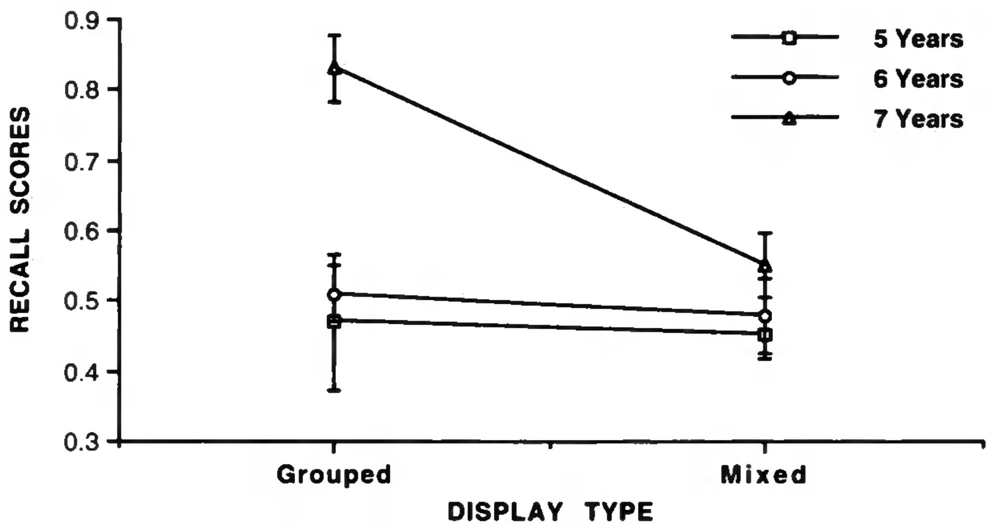
Untransformed means (number of cards recalled) are shown in parentheses.

TABLE 10.13 MEAN RECALL SCORES PER DISPLAY TYPE AND PRESENTATION ORDER

ORDER	MIXED	GROUPED	MEAN TOTAL
MIXED/GROUPED	0.60 (6.71)	0.61 (6.62)	**0.60 (6.67)**
GROUPED/MIXED	0.39 (4.39)	0.60 (6.40)	**0.48 (5.40)**
MEAN TOTAL	**0.49 (5.55)**	**0.60 (6.51)**	

Untransformed means (number of cards recalled) are shown in parentheses.

FIGURE 10.4 INTERACTION OF AGE BY DISPLAY TYPE FOR MEMORY RECALL SCORES



10.2.2.2 ARC CLUSTERING

A 3 (age) x 2 (presentation order) x 2 (display type) analysis of variance was performed on the ARC clustering scores. Due to unequal variances and a proportional score, an arcsine transformation was performed. Those children who's ARC scores were undefined (recalled from only one category, or just one card from each category recalled) were entered into the analyses as 'missing data'. This showed a significant main effect of display type ($F(1,25)=25.42$ $p<.001$), where the grouped display type led to greater clustering at recall than the mixed display type (mean ARC scores = 0.68 and -0.01 respectively). This factor did not significantly interact with age ($F(2,25)=0.68$ $p>.05$), suggesting that this effect was evident at all ages.

10.2.2.3 CLUSTERING CATEGORIES

Based on the children's ARC score they were divided into three categories i.e. extensively strategic, limited strategic and non-strategic. Table 10.14 details the number of children in each category for each display type. For the mixed display type there were no significant differences between the three strategic categories and age groups (Fisher Exact Test ps>.05). For the grouped display type there was one significant difference in that the seven-year-olds showed higher levels of extensive strategy use, than both the five- and six-year-olds (Fisher Exact Test ps<.05).

10.2.2.4 RECALL PERFORMANCE AND CLUSTERING CATEGORIES

A two-way 3 (age) x 3 (category), and a one-way 3 (category) analysis of variance for the mixed and grouped display types respectively, were performed on the arcsine transformed recall scores, in order to compare the relationship between recall performance and the use of the clustering strategy at recall. The factor of age could not be included for the grouped condition due to all the seven-year-olds falling into the extensively strategic category.

There was no significant main effect of clustering category for the mixed display type ($F(2,26)=2.14$ $p>.05$). This effect was however significant for the grouped display type ($F(2,35)=5.23$ $p<.05$). Follow-up analysis revealed that the children using the extensive

TABLE 10.14 STRATEGIC CLUSTERING CATEGORIES

CATEGORY AGE	EXTENSIVELY STRATEGIC	LIMITED STRATEGIC	NON-STRATEGIC	UNDEFINED	TOTAL
MIXED					
5	4	1	5	2	12
6	2	5	6	4	17
7	2	3	7	2	14
TOTAL	8	9	18	8	
GROUPED					
5	5	3	1	3	12
6	8	4	3	2	17
7	14	0	0	0	14
TOTAL	27	7	4	5	

clustering strategy subsequently recalled more cards than the non-strategic children (Scheffe $F(2,35)=7.21$ $p<.05$). The children using the limited strategy shown no significant difference to either of the other two categories of children ($ps>.05$). The mean number of cards recalled were 7.78, 6.00 and 5.00 for the extensive, limited and non-strategic categories respectively. This effect is illustrated in Figure 10.5. It was not possible to assess whether this effect was only evident with the older children.

10.2.2.5 META-MEMORY QUESTIONS

Table 10.15 details the number of children in each age group who responded with either 'grouped', 'mixed', 'neither', 'don't know' or 'did not understand', to the question of which arrangement would help them remember the cards more. Fisher Exact Probability tests on the grouped and mixed responses showed that more 7-year-olds chose the grouped arrangement than the 5-year-olds (Fisher Exact Test $p<.05$). Like Phase 2 the 6-year-olds did not show any significant difference in responding to the 7-year-olds.

Table 10.16 details the number of children in each of the three awareness categories. These relate to the children's justifications of why they thought the arrangement they had chosen would help them to remember the cards. See Appendix J for full details of these categories. In general the 5- and 6-year-olds showed no awareness of how categorical clustering could aid recall, while the 7-year-olds showed extensive awareness of this mnemonic strategy (Fisher Exact Test $ps<.05$).

Eighty-three percent of the 7-year-olds, 55% of the 6-year-olds and 33% of the 5-year-olds who selected the grouped arrangement, subsequently showed extensive awareness of how this would help them to remember the cards. In contrast to the first two phases, the 5-year-olds were now generally able to give a choice of arrangement although they still showed little awareness of why this would aid recall.

10.2.2.6 ASSOCIATION BETWEEN MEASURES

Table 10.17 details the results of the associations between measures. Spearman correlation coefficients were used to compare the relationship between recall

FIGURE 10.5 MAIN EFFECT OF CLUSTERING CATEGORY FOR MEMORY RECALL SCORES

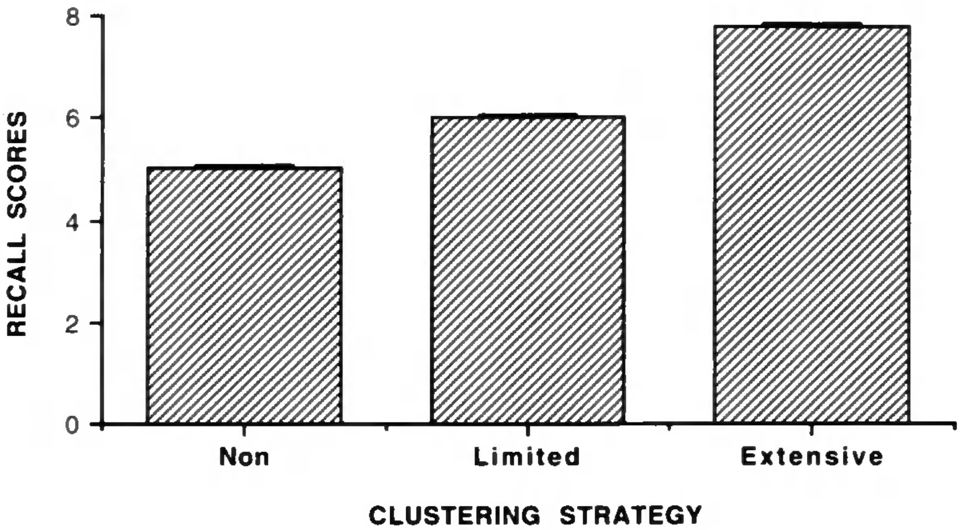


TABLE 10.15 GROUPED/MIXED CHOICE

AGE	GROUPED	MIXED	NEITHER	DONT KNOW	DID NOT UNDER-STAND
5 YEARS	3	6	0	1	2
6 YEARS	11	4	0	0	2
7 YEARS	12	2	0	0	0
TOTAL	26	12	0	1	4

TABLE 10.16 META-AWARENESS CATEGORIES

CATEGORY AGE	EXTENSIVE AWARENESS	LIMITED AWARENESS	NO AWARENESS	TOTAL
5 YEARS	1	3	8	12
6 YEARS	6	2	9	17
7 YEARS	10	2	2	14
TOTAL	17	7	19	

TABLE 10.17 CORRELATIONS AND GAMMA ASSOCIATIONS BETWEEN MEASURES

DISPLAY TYPE	MIXED		GROUPED		
MEASURE	RECALL (r_s)	CLUSTERING CATEGORY (Gamma)	RECALL (r_s)	CLUSTERNG CATEGORY (Gamma)	MIXED/ GROUP (Gamma)
5 YEARS					
CLUSTERING	+0.55		+0.39		
MIX/GROUP	+0.03	+0.20	-0.28	+0.42	
AWARENESS	+0.43	+0.00	+0.05	-0.38	+0.13
6 YEARS					
CLUSTERING	+0.28		+0.28		
MIX/GROUP	-0.13	+0.43	+0.37	+0.38	
AWARENESS	-0.11	+0.09	+0.18	+0.33	+1.00 *
7 YEARS					
CLUSTERING	+0.10		/		
MIX/GROUP	-0.28	+0.00	+0.53 †	/	
AWARENESS	+0.22	+0.38	+0.48	/	+0.67

/ could not be computed because the whole sample were extensively strategic.
† $p=0.05$
* $p<0.05$

performance and clustering categories, the selection of the mixed or grouped arrangement, and the awareness categories. Comparisons between the latter three measures were assessed using the Gamma statistic for ordered variables. All these associations were assessed separately for the two display types and the three age groups. In general, all three age groups showed little relationship between recall ability, strategy use and metacognitive awareness of the clustering strategy as an aid to recall.

More specifically, the five-year-olds showed no significant correlations between recall and the other three measures, or associations between clustering category, mix/group response or awareness of the clustering strategy, for either display type. The six-year-olds showed no significant correlations between recall performance, strategy use and metacognitive awareness, for either display type. There was however a significant association between the mixed/grouped choice and awareness of the clustering strategy ($G= +1.00$ $p<.05$). Those children who selected the mixed arrangement showed no awareness of how this would aid recall, while those children selecting the grouped arrangement showed more extensive awareness. This was equivalent to their performance at Phase 2.

The seven-year-olds showed a significant correlation between recall performance with the grouped display type and the grouped/mix response ($r_s =0.53$ $n=14$ $p=.05$). Therefore increased recall performance when they were shown the cards grouped into their categories, was related to the selection of the grouped arrangement in the meta-awareness task. This age group showed no other significant correlations or associations, although comparisons with clustering category could not be computed due to the whole sample being extensively strategic.

Summary of Main Findings (Memory Task)

1: The seven-year-olds showed significantly higher levels of recall than the five- and six-year-olds. The seven-year-olds showed increased performance with the grouped display type.

2: The grouped display type led to greater clustering of items at recall, for all ages, and subsequently greater proportion of seven-year-olds in the extensively strategic category.

3: The grouped display type led to the children using the extensive clustering strategy recalling a greater number of cards, than the children who were non-strategic.

4: There was a general developmental increase in the children's awareness of how categorical clustering aided recall.

5: There was little relationship between the children's recall performance, strategy use and metacognitive awareness of the clustering strategy.

10.2.3 SELECTIVE ATTENTION TASK

10.2.3.1 SAME/DIFFERENT JUDGEMENTS

Total Number of Accurate Judgements

The total number of accurate judgements each child made across pairs was calculated. Due to unequal variances and a narrow range of scores the number of accurate judgements was divided by the total number possible i.e. four, and an arcsine transformation was performed. Due to an unbalance design a three-way analysis of variance incorporating age, practice order and experimental order was not possible. A one-way between subjects ANOVA showed no effect of the two practice orders (i.e. same/different vs. different/ same) ($F(1,41)=2.69$ $p>.05$). A two-way between subjects ANOVA showed no significant effect of the four experimental orders ($F(3,31)=0.40$ $p>.05$), but did reveal a significant main effect of age ($F(2,31)=4.38$ $p<.05$). Scheffe follow-up analysis on the main effect of age showed that the 7-year-olds produced significantly higher scores than the 6- and 5-year-olds (Scheffe $ps<.01$). The mean number of accurate judgements out of four, were 3.50, 3.14 and 2.46 respectively. This effect is illustrated in Figure 10.6.

Age Differences

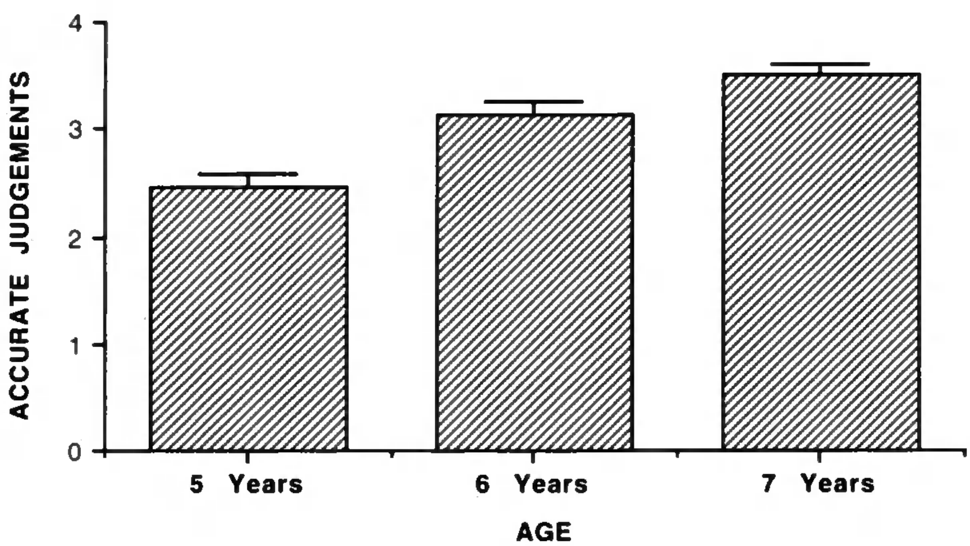
The number of children who responded either same or different for each house pair and age group are shown in Table 10.18.

Pair 1 (same) Each age group had no difficulty in judging that this pair of houses was

TABLE 10.18 SAME/DIFFERENT JUDGEMENTS FOR EACH HOUSE PAIR

	PAIR 1		PAIR 2		PAIR 3		PAIR 4	
AGE	SAME	DIFF-ERENT	SAME	DIFF-ERENT	SAME	DIFF-ERENT	SAME	DIFF-ERENT
5	12	0	5	7	5	7	10	2
6	17	0	3	14	3	14	9	8
7	14	0	3	11	2	12	2	12
TOTAL	43	0	11	32	10	33	21	22

FIGURE 10.6 MAIN EFFECT OF AGE FOR THE TOTAL NUMBER OF ACCURATE JUDGEMENTS



the same. There were therefore no significant age differences (Fisher Exact Test ps>.05). As detailed in Table 10.18, all 43 children accurately judged this pair of house.

Pair 2 (1 difference) There were no significant differences between the ages (Fisher Exact Test p<.05) and therefore like Pair 1, the children generally had no difficulty in judging that this pair of houses was different. The five- and six-year-olds therefore showed an improvement in performance at Phase 2.

Pair 3 (2 differences) There were no significant differences between the ages (Fisher Exact Test p<.05) and therefore like Pair 2, the children generally had no difficulty in judging that this pair of houses was different. The five-year-olds therefore again showed an improvement in performance since Phase 2.

Pair 4 (different locations) Like Phase 2, more seven-year-olds correctly stated that this pair of houses was different compared to the other two age groups (X^2 and Fisher Exact Test ps<.05).

Pair Differences

Comparison of performance across the four house pairs was analysed separately for each age group. Cochran Q tests for related samples showed a significant difference between pairs of the five- and six-year-olds (Q=18.75 d.f.=3 p<.001 and 13.86 d.f.=3 p<.01 respectively). Post hoc Binomial tests showed that for both ages, performance on Pair 1 was significantly greater than performance on Pair 4 (McNemar X^2=8.10 d.f.=1 p<.01 and Binomial d.f.=1 p<.01 respectively). For the seven-year-olds the Cochran Q test was non-significant (Q=4.38 d.f.=3 p>.05), they therefore did not show the reduced performance on Pair 4 demonstrated by the younger age groups.

Therefore Pairs 1, 2 and 3 were relatively easy for each age group, while the 7-year-olds alone were able to accurately judge that a change in spatial location resulted in dissimilarity between the pair of houses.

10.2.3.2 WINDOW OPENING STRATEGIES

Table 10.19 details the number of children using the three different types of window opening strategies. See Appendix K and Chapter 8 Section 1.5 for full details of these. For all four house pairs, more six- and seven-year-olds used an exhaustive strategy than the five-year-olds (Fisher Exact Test $ps<.05$). This pattern of results was therefore equivalent to Phase 2.

10.2.3.3 TOTAL ACCURATE JUDGEMENTS AND OPENING STRATEGY

In order to compare the relationship between the child's total number of accurate judgements and their window opening strategy, the strategy that each child used most predominantly across the four house pairs was assessed. If there was a tie between two strategies, the higher level strategy was recorded. A 3 (category) between subjects analysis of variance was performed on the total number of accurate judgements of similarity/dissimilarity. Due to equal variances and a normal distribution, no transformation was necessary. The factor of age could not be included in the analysis due to no six- and seven-year-olds falling into the non-strategic category.

The ANOVA showed no significant main effect of strategic category ($F(2,40)=2.66$ $p>.05$). The mean number of accurate judgements were 2.50 ($n=2$), 2.63 ($n=16$) and 3.32 ($n=25$) for the non-, limited and exhaustively strategic children respectively. Therefore these means were in the hypothesised direction, however it is possible that the small number of subjects in the non-strategic condition reduced the likelihood of a significant effect.

10.2.3.4 META-AWARENESS QUESTIONS

Table 10.20 details the number of children in each of the three awareness categories, which relate to the children's justifications of their same/difference judgement. See Appendix K and Chapter 8 Section 1.5 for full details of these categories. For Pairs 1, 2 and 4 there were no significant differences between the three categories and age groups (Fisher Exact Test $p>.05$), with the majority of children showing extensive awareness. Pair 3 showed a significant difference in that the five-year-olds showed either no or

TABLE 10.19 WINDOW OPENING STRATEGIES

STRATEGY PAIR/AGE	EXHAUSTIVELY STRATEGIC	LIMITED STRATEGIC	NON-STRATEGIC
PAIR 1			
5 YEARS	1	9	2
6 YEARS	11	5	1
7 YEARS	10	4	0
TOTAL	22	18	3
PAIR 2			
5 YEARS	2	8	2
6 YEARS	12	4	1
7 YEARS	12	2	0
TOTAL	26	14	3
PAIR 3			
5 YEARS	2	7	3
6 YEARS	12	5	0
7 YEARS	8	3	3
TOTAL	22	15	6
PAIR 4			
5 YEARS	1	8	3
6 YEARS	8	7	2
7 YEARS	9	4	1
TOTAL	18	19	6

TABLE 10.20 META-AWARENESS CATEGORIES

CATEGORY PAIR/AGE	EXTENSIVE AWARENESS	LIMITED AWARENESS	NO AWARENESS
PAIR 1			
5 YEARS	6	2	4
6 YEARS	11	3	3
7 YEARS	11	2	1
TOTAL	28	7	8
PAIR 2			
5 YEARS	4	5	3
6 YEARS	11	4	2
7 YEARS	10	2	2
TOTAL	25	11	7
PAIR 3			
5 YEARS	5	2	5
6 YEARS	13	3	1
7 YEARS	10	3	1
TOTAL	28	8	7
PAIR 4			
5 YEARS	7	1	4
6 YEARS	13	3	1
7 YEARS	9	4	1
TOTAL	29	8	6

extensive awareness of the necessity of comparing matching pictures across the house pairs, while both the six- and seven-year-olds only showed high levels of extensive awareness of this ability (Fisher Exact Test ps<.05).

10.2.3.5 ASSOCIATION BETWEEN MEASURES

The Gamma statistic was used to compare the relationship between the same/different judgement, the window opening strategies and the awareness categories. All these associations were assessed separately for the four house pairs and the three age groups. The results of these comparisons are detailed in Table 10.21. In general, an accurate judgement about the similarity/dissimilarity of the house pairs was associated with the use of the more exhaustive window opening strategies, and awareness of the necessity to compare homologous windows in order to justify this judgement.

More specifically, the five-year-olds only showed significant associations for Pair 4 in that the same/difference judgement was associated with both their opening strategy and awareness (G= +1.00 ps<.05). An accurate judgement was associated with an exhaustive window opening strategy and extensive awareness of the necessity of comparing homologous window in order to justify their judgement. The six-year-olds also showed this pattern of behaviour for Pairs 2 and 3. For Pair 4 they showed a negative association between the same/difference judgement and awareness (G= -0.67 p<.05), in that 47% of subjects judged inaccurately that this pair of houses were the same and were able to extensively justify this decision. For Pairs 3 and 4 they showed how the use of a exhaustive window opening strategy was associated with extensive awareness of the necessity to compare homologous windows (ps<.05).

The seven-year-olds showed significant associations between the same/different judgement and awareness for Pairs 2 and 3 (G= +1.00 ps<.05), in that the majority of children gave an accurate judgement and were able to extensively justify this decision. For Pair 2 they showed a negative association between the same/difference judgement and their opening strategy (G= -1.00 p<.05) in that, unlike the other age groups, those children who made an accurate judgement used either a limited or an exhaustive window

TABLE 10.21 GAMMA ASSOCIATIONS BETWEEN MEASURES

	5 YEARS		6 YEARS		7 YEARS	
MEASURE	S/D	Strategy	S/D	Strategy	S/D	Strategy
PAIR 1						
Strategy	/		/		/	
Awareness	/	+0.05	/	+0.37	/	+0.25
PAIR 2						
Strategy	+0.56		+0.63 †		-1.00 *	
Awareness	+0.45	+0.54	+0.69 *	+0.29	+1.00 *	+0.29
PAIR 3						
Strategy	-0.20		+0.76 †		+0.33	
Awareness	+0.72	+0.41	+1.00 **	+0.89 *	+1.00 *	+0.74 *
PAIR 4						
Strategy	+1.00 *		-0.06		+0.23	
Awareness	+1.00 *	-0.14	-0.67 *	+0.60 *	+0.38	+0.54

S/D Same/Different judgement.
/ could not be computed because the whole sample responded with "same".
† p=0.05
* p<0.05
** p<0.01

opening strategy, while the few children who made an inaccurate judgement all used an exhaustive strategy. This age group also showed how the use of a exhaustive window opening strategy was associated with extensive awareness for Pair 3 ($G= +0.74$ $p<.05$).

Summary of Main Findings (Selective Attention Task)

1: More seven-year-olds accurately judged the similarity/dissimilarity of the house pairs than the five- and six-year-olds.

2: All ages were able to accurately differentiate the same and different house pairs. The seven-year-olds alone were able to accurately judge that a change in the spatial location of the pictures resulted in dissimilarity between house pairs.

3: There was a general developmental increase in the use of exhaustive window opening strategies.

4: The use of the exhaustive strategy did not led to a significant increase in the ability to differentiate house pairs.

5: The majority of children showed extensive awareness of the necessity to compare matching pictures across house pairs in order to justify their judgements.

6: An accurate same/difference judgement was associated with the use of exhaustive window opening strategy and extensive awareness of the necessity to compare homologous pictures across house pairs, in order to justify this judgement.

10.2.4 TASK EFFECTS

In order to assess how the children's abilities compared across the three tasks, Spearman rank-order correlation coefficients were used to compare performance levels, and the Friedman two-way analysis of variance by ranks was used to compare strategic and awareness categories, separately for each age group.

10.2.4.1 PERFORMANCE

The children's drawing realism for both the cup and ball task, their recall score for the mixed and grouped display type, and their total same/difference score across the four house pairs, were correlated with each other. As can be seen from Table 10.22, the five-

TABLE 10.22 CORRELATIONS FOR COMPARISON OF PERFORMANCE BETWEEN TASKS

	Drawing Realism (Ball Task)	Drawing Realism (Cup Task)	Same/Difference Judgement
FIVE-YEAR-OLDS			
Recall (Mixed)	/	-0.12	+0.66 *
Recall (Grouped)	/	+0.12	+0.31
Same/Difference	/	+0.18	
SIX-YEAR-OLDS			
Recall (Mixed)	+0.26	+0.26	-0.36
Recall (Grouped)	+0.29	+0.29	-0.33
Same/Difference	-0.09	-0.09	
SEVEN-YEAR-OLDS			
Recall (Mixed)	+0.18	-0.09	+0.26
Recall (Grouped)	-0.61 *	-0.65 *	+0.54 *
Same/Difference	-0.02	-0.33	

/ could not be computed as whole sample was intellectually realistic.
* $p<0.05$

year-olds showed a significant correlation between performance on the memory (mixed display type) and selective attention tasks (r_S =0.66 n=12 p<.05). Therefore an increased ability to accurately differentiate house pairs was related to an increased ability to recall picture cards when the clustering mnemonic was not prompted.

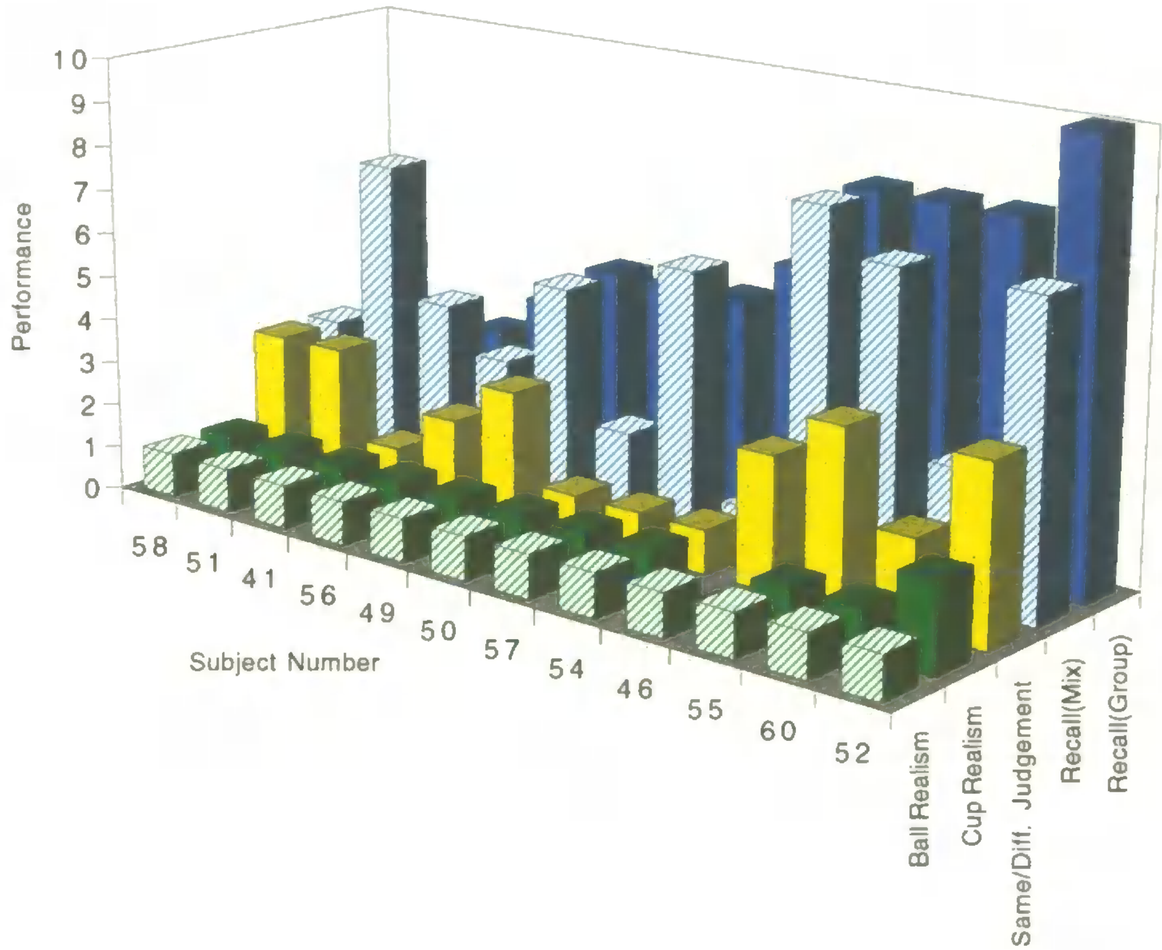
Like Phase 2, the six-year-olds showed no significant correlations between the tasks. For the seven-year-olds, recall performance with the grouped display type significantly correlated with the other two tasks. Drawing realism for both tasks showed negative correlations (r_S = -0.62 and -0.65 ns=14 ps<.05 for the ball and cup models respectively), in that the few subjects who were intellectually realistic (Subjects 29, 32 and 40) also recalled a greater number of cards. The one subject (Subject 35) who performed particularly poorly on this memory task, also showed a reduced ability to accurately differentiate the house pairs in the selective attention task (r_S =0.54 n=14 p<.05). This analysis therefore appears to have been affected by low subject numbers. Figures 10.7, 10.8 and 10.9 illustrate more clearly the relationships between measures for the five-, six- and seven-year-olds respectively. Figure 10.9 shows the performance of the particular subjects mentioned above.

10.2.4.2 STRATEGIC ABILITIES

Friedman tests were used to assess whether children's strategic ability (non-strategic, limited strategic, extensively strategic) differed across the three tasks. Therefore for each age group, four tests were calculated between strategic attentional ability (ball and cup tasks), memory clustering ability (mixed and grouped display type) and the most predominant window opening strategy used across the four house pairs. The results of these are shown in Table 10.23.

Like Phase 2, the five-year-olds showed a difference in their strategic behaviour for the ball task compared to the grouped display type and their window opening strategy (F_r=8.86 d.f.=2 p<.05). Multiple comparisons between tasks revealed that strategic attention on the drawing task was significantly lower than their clustering ability on the memory task. Therefore the children were reacting to the prompt to use the strategy.

FIGURE 10.7 **FIVE-YEAR-OLDS PERFORMANCE COMPARISON**



NOTES:

The subjects are ranked in order of their recall performance on the memory task with the grouped display type [labelled 'Recall(Group)'].

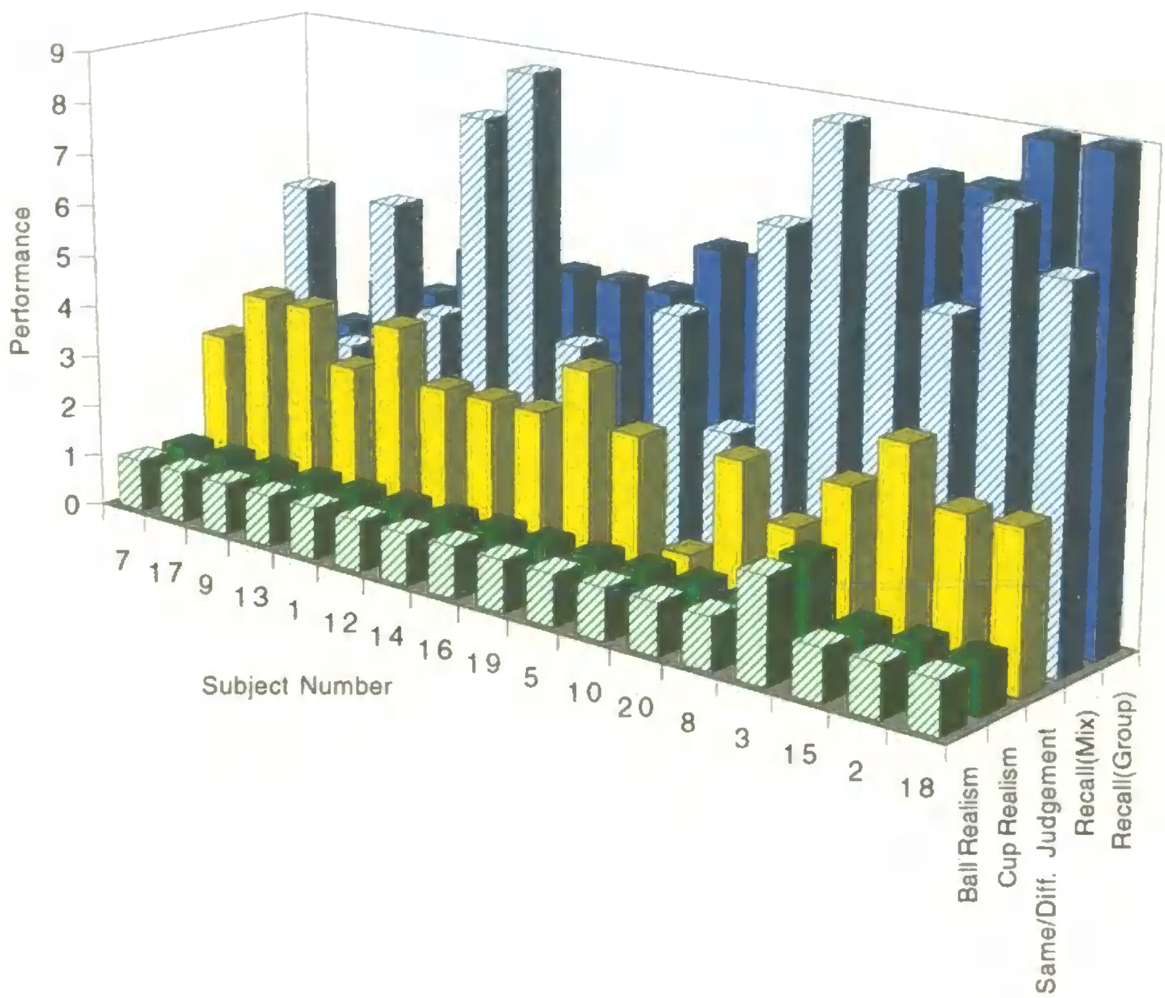
The scales are different for the three tasks.

For the drawing tasks (labelled 'Ball Realism' and 'Cup Realism') the children scored two if they visually realistic, one if they were intellectually realistic and zero if they were neither of these e.g. they scribbled.

For the selective attention task (labelled 'Same/Diff. Judgement') the childrens' scores ranged from zero to four correct judgements.

For the memory task [labelled 'Recall(Mix)' and 'Recall(Group)'] the childrens' scores ranged from zero to twelve cards recalled.

FIGURE 10.8 SIX-YEAR-OLDS PERFORMANCE COMPARISON

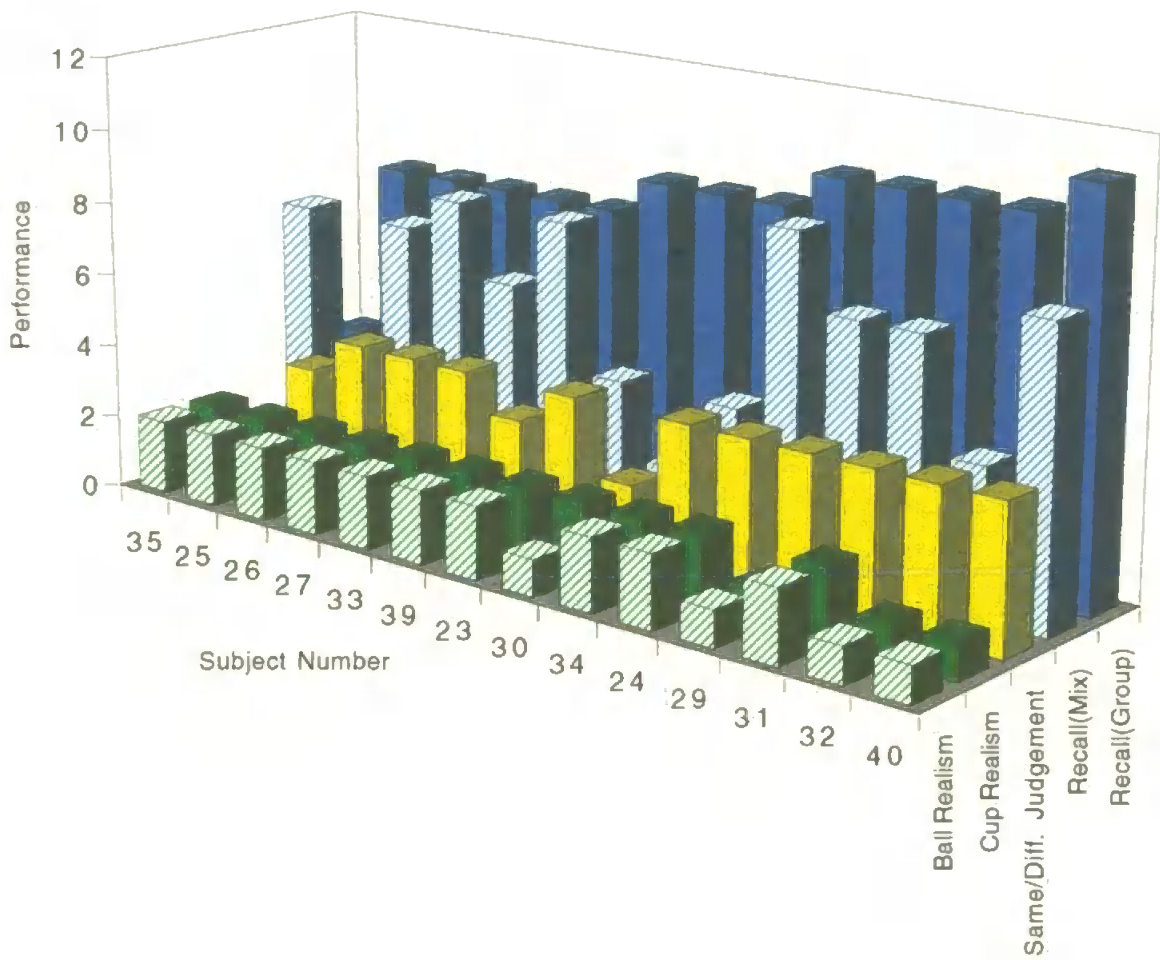


NOTES:

The subjects are ranked in order of their recall performance on the memory task with the grouped display type [labelled 'Recall(Group)'].

The scales are different for the three tasks.
For the drawing tasks (labelled 'Ball Realism' and 'Cup Realism') the children scored two if they visually realistic, one if they were intellectually realistic and zero if they were neither of these e.g. they scribbled.
For the selective attention task (labelled 'Same/Diff. Judgement') the childrens' scores ranged from zero to four correct judgements.
For the memory task [labelled 'Recall(Mix)' and 'Recall(Group)'] the childrens' scores ranged from zero to twelve cards recalled.

FIGURE 10.9 SEVEN-YEAR-OLDS PERFORMANCE COMPARISON



NOTES:

The subjects are ranked in order of their recall performance on the memory task with the grouped display type [labelled 'Recall(Group)'].

The scales are different for the three tasks.

For the drawing tasks (labelled 'Ball Realism' and 'Cup Realism') the children scored two if they visually realistic, one if they were intellectually realistic and zero if they were neither of these e.g. they scribbled.

For the selective attention task (labelled 'Same/Diff. Judgement') the childrens' scores ranged from zero to four correct judgements.

For the memory task [labelled 'Recall(Mix)' and 'Recall(Group)'] the childrens' scores ranged from zero to twelve cards recalled.

TABLE 10.23 FRIEDMAN TESTS FOR COMPARISON OF STRATEGIC ABILTITY BETWEEN TASKS

TASK COMPARISONS †	SUM OF RANKS DRAW	MEM.	S.A.	F_r	D.F.	P.
FIVE-YEAR-OLDS						
Att.(ball) / Cluster(mixed) / WO	17.0	20.0	23.0	2.400	2	n.s.
Att.(ball) / Cluster(grouped) / WO	12.0*	23.0*	19.0	8.857	2	<0.05
Att.(cup) / Cluster(mixed) / WO	21.5	19.0	19.5	0.412	2	n.s.
Att.(cup) / Cluster(grouped) / WO	18.0	20.0	16.0	1.185	2	n.s.
SIX-YEAR-OLDS						
Att.(ball) / Cluster(mixed) / WO	19.0	20.5	<u>32.5</u>	11.231	2	<0.01
Att.(ball) / Cluster(grouped) / WO	18.5*	29.5	36.0*	15.268	2	<0.001
Att.(cup) / Cluster(mixed) / WO	19.0	20.0	<u>33.0</u>	13.189	2	<0.01
Att.(cup) / Cluster(grouped) / WO	21.5*	28.0	34.5*	8.244	2	<0.05
SEVEN-YEAR-OLDS						
Att.(ball) / Cluster(mixed) / WO	24.0	17.0*	31.0*	10.316	2	<0.01
Att.(ball) / Cluster(grouped) / WO	22.0	32.5	29.5	8.667	2	<0.05
Att.(cup) / Cluster(mixed) / WO	24.0	16.5*	31.5*	12.500	2	<0.01
Att.(cup) / Cluster(grouped) / WO	22.5	32.0	29.5	10.211	2	<0.01

† Att.(ball) = Strategic attention for ball drawing task.
Att.(cup) = Strategic attention for cup drawing task.
Cluster(mixed) = Clustering strategy for mixed display type.
Cluster(grouped) = Clustering strategy for grouped display type.
WO = Window opening strategy for selective attention task.

* Significant differences at follow-up.

__ Significantly different from the other two tasks.

Unlike Phase 2 this age group did not show this pattern of results with the cup task. As can be seen in Table 10.23, they seem to have been more strategic with the cup model (in comparison to the ball model) relative to the memory and selective attention tasks.

The six-year-olds showed significant differences for all four comparisons (ps<.05). Follow-up analysis revealed that their strategic window opening ability was superior to their strategic attentional ability for both the cup and the ball models, and their clustering ability with the mixed display type. There were no significant differences between window opening strategies and clustering strategies with the grouped display type i.e. when the strategy was prompted. These results were therefore different to Phase 2 where this age group showed comparable strategic abilities across the tasks.

The seven-year-olds also showed significant differences for all four comparisons (ps<.05). However follow-up analysis only revealed that their memory clustering ability with the mixed display type was significantly lower than their strategic window opening ability. Therefore when the mnemonic strategy was not prompted by the display of the cards at encoding, there was a reduction in strategic ability. This therefore reflected the results of Phase 2.

10.2.4.3 META-AWARENESS

Friedman tests were used to assess whether the children's meta-awareness (no awareness, limited awareness, extensive awareness) differed across the three tasks. Therefore for each age group, two tests were calculated between awareness of the attentional strategy in the drawing task (ball and cup), metamemory awareness and the most predominant awareness category shown across the four house pairs on the selective attention task. The results of these are shown in Table 10.24.

Like Phase 2, all comparisons were shown to be significant (ps<.05). For the five-year-olds multiple comparisons between tasks revealed that their awareness of the necessity to compare homologous windows in order to justify their judgement on the selective attention task, was superior to awareness of the clustering strategy with the memory

TABLE 10.24 FRIEDMAN TESTS FOR COMPARISON OF METACOGNITIVE AWARENESS BETWEEN TASKS

TASK COMPARISONS †	SUM OF RANKS DRAW	MEM.	S.A.	F_r	D.F.	P.
FIVE-YEAR-OLDS						
Drawing(ball) / Metamemory / SA	24.0	18.0*	30.0*	7.024	2	<0.05
Drawing(cup) / Metamemory / SA	24.0	18.5	29.5	6.368	2	<0.05
SIX-YEAR-OLDS						
Drawing(ball) / Metamemory / SA	29.0	28.0	45.0	13.236	2	<0.01
Drawing(cup) / Metamemory / SA	28.5	28.5	45.0	13.444	2	<0.01
SEVEN-YEAR-OLDS						
Drawing(ball) / Metamemory / SA	18.0*	30.5	35.5*	14.444	2	<0.001
Drawing(cup) / Metamemory / SA	17.5	31.0	35.5	18.474	2	<0.001

† SA = Selective Attention task.
* Significant differences at follow-up.
__ Significantly different from the other two tasks.

task, but only for the comparison with the ball model.

For the six-year-olds, multiple comparisons between tasks revealed that the children's awareness on the selective attention task was superior to awareness on all other tasks. For the seven-year-olds awareness on both the ball and the cup task was less than their awareness on the selective attention task, and in addition awareness of the clustering strategy on the memory task was superior to their awareness with the cup task.

Summary or Main Findings (Task Effects)

1: The five- and seven-year-olds showed some comparable performance across the three tasks. For the five-year-olds increased recall with the mixed display type correlated with increased accuracy to differentiate the house pairs on the selective attention task. For the seven-year-olds increased recall with the grouped display type correlated with reduced drawing ability and increased accuracy to differentiate house pairs.

2: The five-year-olds showed superior ability to use the mnemonic strategy when it was prompted, than they did to use an attentional strategy in the ball drawing task. The six- and seven-year-olds showed an increased ability to use the exhaustive window opening strategies than they did to use the mnemonic strategy when it was not prompted, and additionally the six-year-olds showed reduced ability to use the attentional strategy in the drawing task.

3: All three age groups showed increased awareness of the necessity to compare homologous windows in the selective attention task.

10.3 DISCUSSION

10.3.1 DRAWING TASK

There was no overall change in the age related differences in drawing performance since the previous phase. The seven-year-olds were still showing superior performance compared to the younger two age groups. There was a marked difference between the performance of the seven- and six-year-olds, with 79% of seven-year-olds but only one six-year-old producing a visually realistic drawing. However subject numbers were low, and it has been documented that six-year-olds generally need a prompt in order to produce visually realistic drawings i.e. presentation of explicit instructions (Barrett, Beaumont & Jennett, 1985). However in Study 1 (Chapter 2) the six-year-olds showed equal proportions of visually and intellectually realistic drawings with an identical cup model and standard instructions. In Study 3 (Chapter 4) for the same partial occlusion ball model in the standard instruction condition, 60% were intellectually and 20% were visually realistic. Therefore both these studies showed higher levels of visual realism, however subject numbers were greater and the mean age was six years four months as opposed to six years one month in the present study. There was also the added problem that half the visually realistic children from this age group at Phase 1, were unavailable at Phases 2 and 3, while *all* the intellectually realistic children were available. Therefore it is possible that this attrition of subjects could have adversely affected the pattern of results, in that the intellectually realistic population at Phases 2 and 3 appeared to be disproportionately inflated in comparison to the visually realistic population.

There was however an increase in the number of children showing comparable performance across the two drawing tasks. At Phases 1 and 2, 72% and 74% of subjects produced two drawings of the same type, while 93% of children at Phase 3 showed such comparable performance. The majority of five- and six-year-olds were still intellectually realistic on both tasks, while 71% of the seven-year-olds were visually realistic on both, as opposed to 60% at Phase 2. The older age group had therefore improved their drawing performance while the younger two age groups seem to have remained at an intellectually realistic level. The results of Chen & Holman (1989) were therefore refuted, in that there was no evidence of a disparity between performance on these two tasks. They showed that by seven years of age 94% of children were able to omit the hidden handle in their drawings of a cup, but only 54% were able to use hidden line elimination to depict one ball partially occluded by another. However their procedure and instructions were slightly different to the present study. Nevertheless, performance levels of these two tasks with standard instructions were increasingly comparable with age.

The seven-year-olds spent more time attending to the models than the six-year-olds, although they took the same number of looks. It was possible that they were therefore attempting to gain as much benefit as possible from each look at the drawing models, by presumably paying more detailed attention to them. This was clearly demonstrated by the increase in looking 'within' drawing a particular element of the cup model, although this was evident at all ages. The children were therefore paying more detailed attention where it was appropriate, and were adapting their behaviour to the particular demands of the two models.

Consistent with this was the comparison of the attentional behaviour of the visually and intellectually realistic children. Although they showed no difference in the number of looks paid towards the models, the visually realistic drawers spent more time attending than the intellectually realistic drawers, at all ages. For the cup model, this pattern of behaviour was only significant for the 'beginning' look type, but although the 'within' looking of the visually realistic drawers appeared to be higher than for the intellectually realistic drawers, it was not significantly so. Therefore the visually realistic drawers, who were mainly the seven-year-olds, did not show particularly high levels of 'within' looking. This was reflected in the lack of a significantly higher number of children in the extensively strategic category. There were generally fairly even numbers of extensively and non-strategic children at all ages. A non-strategic child only attended to the model at the beginning of the task at a lower than average level (above average would be consistent with a limited strategy). Therefore although the seven-year-olds were producing visually realistic drawings they were not being particularly strategic in their attentional behaviour. This was possibly due to the simplicity of the tasks particularly for this older age group.

There were no significant differences between the age groups with regard to their level of awareness of the attentional strategy of continued attention to the drawing models. The majority of children (74% for the cup task, and 84% for the ball task) showed limited awareness. This category related to knowledge and description of the objects, and a general confidence in their ability to draw them e.g. "its easy to draw". Therefore giving no reference to the necessity of attending to the model. However these responses were reflected in the fact that the majority of children (86%) felt that they would have no problem with drawing the models if they were just shown to them and then hidden from view before they started to draw. These results were also consistent with the seeming lack of necessity to strategically attend to the model. It is possible that the simplicity of the tasks led to the older children being able to draw their view of them without continued attention, and for all children to believe (correctly, or incorrectly in the case of the younger age groups) in their own drawing abilities.

With regard to the relationships between drawing performance, strategy use and awareness, the five-year-olds showed a strong relationship between being intellectually realistic on the cup task and the use of a limited attentional strategy. This was equivalent to their performance at Phase 1. Therefore for this younger age group, paying greater than average attention at the beginning of the task, led to the production of an intellectually realistic drawing i.e. they included the hidden handle. It is possible that they took time to consider the fact that it was a cup, but that they could not see the handle, and subsequently to decide that they should include the handle in their drawing, presumably in order to portray an unambiguous cup.

The six-year-olds showed how increased strategy use was related to increased awareness of this attentional strategy. This was therefore equivalent to their behaviour at Phase 2, and the oldest age group at Phase 1 when they were also six years of age. This age group therefore showed an improvement on the five-year-olds who showed some signs of being strategic but had no awareness, whereas for the six-year-olds those few subjects who showed improved strategic abilities also showed higher levels of awareness. It is possible that use of the strategy leads to awareness or the reverse i.e. increased awareness leads to strategy use.

Equivalent to the other phases, this age group showed how believing that they would be able to draw the model even if it was hidden from view while drawing, was associated with limited awareness. The one subject who responded with "no" to the original metacognitive question, justified this by referring to the necessity to attend to the model. The opposite pattern was shown by the five- and seven-year-olds, in that the few children who responded with "no" subsequently showed no awareness of the attentional strategy. This was therefore inconsistent with the previous phases. However as the number of subjects who responded with "no" were so low with this phase (i.e. two, one and two for the five-, six- and seven-year-olds respectively) it would be inappropriate to draw any firm conclusions from this pattern of results.

The results of the drawing task therefore show that the seven-year-olds showed superior drawing performance in comparison to the younger two age groups. This was not however reflected in a general increase in attentional strategy use, or increased awareness of the strategy, presumably due to the simplicity of the tasks for this older age group. Individually however, the five-year-olds showed how the use of a limited attentional strategy was associated with being intellectually realistic, and the six-year-olds showed how an increase in the level of strategy use was reflected in increased awareness of the necessity of attending to the drawing models in order to produce an accurate drawing.

10.3.2 MEMORY TASK

For the memory task, the seven-year-olds showed superior recall ability over the other two age groups, due to their continued benefit from the use of the mnemonic strategy of clustering the items into conceptual categories at recall. When this mnemonic was prompted to the children, by presenting the cards in their categories at encoding, the seven-year-olds showed high levels of extensive strategy use, which was not evident with the mixed display type. However the ARC clustering scores did show a significant improvement with the grouped display type, for all three ages. Therefore even the younger children were using the prompt to increase their clustering, however this was not reflected in significant increases in recall performance until seven years of age. It is possible that this is due to a lack of metacognitive awareness in the younger children. If they are not aware of how clustering can aid recall they would not know how to use this prompt to its best advantage.

Unlike the first two phases, there was a significant difference between the recall performance of the children in the three clustering categories, but consistent with the above, this was only evident for the grouped display type. Therefore the children who were extensively strategic in this condition showed superior recall ability. It was however not possible to assess whether this effect was evident at all ages, or whether the main effect was accounted for by the seven-year-olds alone. Inspection of the means would seem to suggest that although the whole seven-year-old sample were in the extensive category and recalled a high number of cards, the other two age groups showed a gradual rise in recall ability between the non-, limited, and extensive strategic categories. This would seem to suggest that extensive strategy use led to increases in recall at all ages, although this could not be statistically substantiated.

The majority of the six- and seven-year-olds were able to correctly judge that the grouped arrangement of cards would aid their recall performance, however only the seven-year-olds showed *consistent* knowledge of why this was the case i.e. due to the clustering of the cards. In contrast 50% of the five-year-olds chose the mixed arrangement, however this was a vast improvement on previous phases were 45% and 57% of this age group did not understand the task and generally just pointed to an individual card. However although they were now able to give a choice, it was incorrect and they showed little awareness of how clustering could aid recall.

There were very few significant relationships between the children's recall performance, strategy use and metacognitive awareness, however subject numbers were relatively low.

The six-year-olds did show how the selection of the grouped arrangement was associated with extensive awareness of the clustering strategy. However this only applied to 55% of the children who selected the grouped arrangement, which was in comparison to 83% of the seven-year-olds making this choice and being able to accurately justify it. However the remaining 17% of seven-year-olds making this choice were unaware of the clustering strategy and this therefore resulted in a non-significant association between mix/group choice and awareness for this age group. This therefore illustrates the problem of assessing these associations on small sample sizes, as a few subjects performing differently to the rest of the sample can lead to non-significant effects. The seven-year-olds also showed how increased recall with the grouped display type was correlated with choice of the grouped arrangement, however again this correlation was adversely affected by one child who selected the mixed arrangement and only recalled three out of the possible twelve cards, which was well below the group average of 8.6 cards.

The results of the memory task therefore revealed that the seven-year-olds showed superior recall, strategic and awareness abilities compared to the younger two age groups. However all ages responded to the prompt to use the clustering strategy although the performance levels of the five- and six-year-olds did not show any benefit from this. The seven-year-olds and to some extent the six-year-olds, showed how selection of the grouped arrangement in the metacognitive task was related to an ability to justify this decision by referring to the clustering of the cards. Although the five-year-olds showed little awareness of this, they did show an improved ability to understand the metacognitive task.

10.3.3 SELECTIVE ATTENTION TASK

The children's overall performance on the selective attention task reflected those of the other two tasks, in that the seven-year-olds showed a superior ability to accurately differentiate the house pairs compared to the younger two age groups. With regard to the individual house pairs, all three ages were able to differentiate Pairs 1, 2 and 3 i.e. when they were the same, and when there was one or two differences between the pairs.

Therefore, both the five- and six-year-olds improved their ability to differentiate the house pairs when there was one difference, and the five-year-olds also showed improvement when there were two differences. Only the seven-year-olds were able to accurately judge dissimilarity when the spatial locations of the pictures were changed (Pair 4). This pair therefore continued to be the most difficult to differentiate.

Strategic search behaviour was shown to increase with age particularly between the five- and six-year-olds. Seventy percent of seven-year-olds, 63% of six-year-olds and 13% of five-year-olds used an exhaustive window opening strategy. These results therefore agreed with Vurpillot (1968). However unlike the previous two phases, the children using these strategies did not show an increased accuracy to differentiate the house pairs. This seems to have been caused by the five-year-olds who mainly used a limited opening strategy and generally only half of these children subsequently made an accurate judgement regarding the similarity/dissimilarity of the particular house pair. The older two age groups were using the more exhaustive strategies and made more accurate judgements. It was not however possible to statistically assess whether there was a significant interaction with age or not.

The majority of children were able to extensively justify their judgements regarding the house pairs by showing awareness of the necessity of comparing the matching pictures. This pattern was generally evident for all four house pairs and all three ages. Therefore the five-year-olds showed an improvement in performance in comparison to Phase 2. These children were now older than the sample assessed by Day & Bissell (1978), who found that they were systematic in their justifications but not in the same way as adults. This would be roughly consistent with limited awareness in the present study. They did not however assess children older than four years eleven months, therefore it is unsure when they would progress to more extensive levels of awareness. Miller & Weiss (1981) assessed the metacognitive awareness of children aged between seven and thirteen, but only found that 16% of the seven-year-olds believed that they had used a strategy of only attending to the relevant information in a central-incidental selective attention task. The seven-year-olds were therefore showing much lower levels of awareness than in the present study. However as the two selective attention and metacognitive tasks were quite different it is difficult to accurately compare performance across the two studies.

With regard to the associations between measures, the majority of five-year-olds for Pair 4, made an inaccurate judgement, were limited in their strategy use and showed either no or extensive awareness. However it was noticeable that a few subjects were performing at a more advanced level than the rest of their age group by making accurate judgements, using an exhaustive window opening strategy and showing extensive awareness.

The six-year-olds also showed how an accurate judgement was associated with exhaustive window opening strategies and with extensive awareness, however unlike the five-year-olds this pattern of results was evident in 65% of this age group. At Phase 2 these children had shown the association between judgement and awareness with Pair 3 where they had shown fairly accurate judgements of dissimilarity. At the present phase they were fairly accurate at assessing Pairs 2 and 3, and it was noticeable that their ability to differentiate and to justify this decision was also now associated for both these pairs. Therefore an ability to accurately judge the house pairs seems to develop along with an ability to justify this decision, for this age group at least. For Pair 4 this association was negative in that stating inaccurately that the houses were the same was associated with extensive justification of this. This age group were still having difficulties with this particular pair, in that they did not seem to appreciate that the pictures needed to be in the same spatial locations, and therefore judged the houses to be the same. However they are able to extensively justify this by matching all the picture pairs across the two house, irrespective of the location of them. They were therefore systematic in their performance but were not using the same criteria of similarity/dissimilarity as the seven-year-olds. Therefore with this difficult pair, the six-year-olds behaviour reflected that of the younger children.

The seven-year-olds showed associations between extensive awareness of the necessity of comparing matching pictures and both accurate judgements and exhaustive window opening strategies. However unlike Phase 2, they did not show an association between the latter two measures. This age group therefore showed some evidence of a relationship between performance, strategy use and awareness, but the results were not as consistent as at the previous phase.

The results of the selective attention task show that the seven-year-olds only showed a superior ability to differentiate the house pairs where the spatial locations were changed. All three age groups were able to accurately judge the pairs if they were the same, or if they had one or two differences. All three age groups were also consistently able to justify their decisions, which was reflected in the consistent associations between this measure and both judgement accuracy and strategy use for all ages. The use of an exhaustive window opening strategy was not particularly evident in the five-year-olds, which was also reflected in a lack of association between strategy use and either their judgement accuracy or, unlike the older two age groups, their awareness of the necessity of comparing homologous windows in order to justify their judgement.

10.3.4 TASK EFFECTS

Comparison of performance within each of the three tasks showed that for the memory and drawing tasks, the seven-year-olds out performed the younger age groups, however selective attention performance was fairly consistent across ages, except for the most difficult pair. Direct comparison between the tasks themselves revealed that, like the other phases, the children's performance levels were not particularly comparable, except for the five- and seven-year-olds. The five-year-olds showed how increased recall ability with the mixed display type correlated with an increased ability to differentiate the house pairs. The seven-year-olds showed how increased recall on the grouped display type correlated with reduced drawing realism on both cup tasks, but an increased ability to differentiate house pairs.

Strategic abilities were generally affected by the particular demands of the three different tasks. Prompting the five-year-olds to use the mnemonic strategy led to increases in strategic ability, in comparison to their strategy use in the drawing task which did not provide any prompt, as only standard instructions were presented to the children. The six- and seven-year-olds increased strategy use for the selective attention task was also evident with this analysis. For the six-year-olds, this ability was superior to their attentional strategy use in the drawing task, and their clustering in the memory task (mixed display type). In both these cases the strategies were not prompted by either explicit instructions or the display of the cards at encoding. However when they were prompted to use the strategy in the memory task (grouped display type), their strategic ability was not significantly lower than in the selective attention task. Similarly the seven-year-olds showed higher levels of strategic ability in the selective attention task in relation to the memory task (mixed display type), but not in relation to the drawing task. However this age group does not generally need explicit instructions and showed high levels of 'within' looking and therefore were extensively strategic in the drawing task, even with the standard instructions.

The generally high levels of metacognitive awareness in the selective attention task for all ages was also evident with this across task analysis. The five-year-olds showed greater awareness of this, than on the memory task, but not the drawing task. However this age group had particular problems with the metamemory task and therefore it was not surprising that they showed low levels of awareness for this. The six-year-olds showed superior awareness on the selective attention task than they did on both the drawing tasks and the memory task, and the seven-year-olds showed greater awareness than just the drawing tasks. This older age group did not have any problems with the metamemory task and therefore did not show such reduced levels of awareness, while for the drawing task, the strategy of continued attention could be quite subtle and it was possible that they had little conscious awareness of using this.

10.3.5 CONCLUSIONS

The view that children develop a general strategic ability or understanding that filters through to all tasks was generally supported, although this was affected by the demands of the task and by exposure or experience of these tasks. The strategic and metacognitive awareness abilities on the selective attention task were generally superior to the other two tasks (except where the task demands were reduced). The children had increased exposure to this task due to being presented with six examples of house pairs (including the practice pairs) at each phase, therefore resulting in a total of eighteen trials over the one year period. For the drawing and memory tasks the children only received a total of six trials of each. It was also noted that the children increasingly remembered the selective attention task more across each phase. Therefore it is possible that this increased exposure accounted for the increase in abilities, particularly at Phase 3. It was also noticeable that although there were few correlations between performance levels across tasks, the two that were present at Phase 2, and two out of the three that were present at Phase 3, related to the selective attention task. Therefore the evidence seems to support the view that children develop a general strategic understanding that filters through to different cognitive tasks, but that when this is combined with increased exposure or experience of a particular task, this strategic ability translates into increased performance levels.

The age related differences have remained fairly consistent across the three phases, with the seven-year-olds generally showing superior abilities compared to the younger two age groups. However it is possible that the three age groups have all improved at a similar rate. Certainly mean levels of performance have increased, along with increases in strategy use and metacognitive awareness of these strategies. Therefore analysis of performance across the three phases is necessary in order to assess these changes more accurately.

CHAPTER 11

LONGITUDINAL PHASE ANALYSIS

11.1 METHOD

11.1.1 SUBJECTS

Data was available from the forty-three children who were present at each of the three phases of assessment. There were twelve children in the youngest age group, with mean ages of 3 years 11 months, 4 years 6 months and 4 years 11 months at Phases 1, 2 and 3 respectively. There were seventeen children in the middle age group, with mean ages of 5 years 1 month, 5 years 7 months and 6 years 1 month at Phases 1, 2 and 3 respectively. There were fourteen children in the oldest age group, with mean ages of 6 years 11 months, 7 years 5 months and 7 years 11 months at Phases 1, 2 and 3 respectively. These groups will subsequently be referred to as cohorts 1, 2 and 3. There were twenty-two males and twenty-one females.

11.1.2 DATA ANALYSIS

Within subjects proportional data, i.e. drawing realism, the yes/no metacognitive responses for the drawing task, and the grouped/mixed metacognitive responses for the memory task were analysed using the Cochran Q test for related samples (Siegel, 1956). As no specific follow-up analysis was available the McNemar test for significant changes was used, however the significance level was set at 0.025 rather than 0.05. If the expected cell frequencies were less than five the Binomial test was used again with a 0.025 significance level.

Analysis of Variance (ANOVA) was used to assess the amount of attention paid towards the drawing model, memory recall responses, ARC clustering scores and the total number of accurate same/different responses for the selective attention task. Where the assumption of homogeneity of variance between conditions was not met, transformations were performed on the raw data according to the criteria detailed in Howell (1987).

Significant differences were assessed using Scheffe's method of multiple comparison of means (See Appendix A for full details).

Categorical data i.e. strategic and metacognitive awareness abilities, were assessed across the three phases using the Friedman two-way analysis of variance by ranks. This was used because each child's performance could be ranked across the three phases, in order to assess whether or not the ranking of phases varied systematically.

11.2 RESULTS

The following sections detail the main findings of the analyses. The full analysis of variance summary tables, details of the subsidiary results and frequency data for the Friedman tests are given in Appendix O.

11.2.1 DRAWING TASK

11.2.1.1 DRAWING DATA

The number of children in each age group and at each phase, producing visually or intellectually realistic drawings in response to the two models are shown in Table 11.1.

For both the cup and the ball drawing, Cochran tests showed no significant differences between the proportions of visually and intellectually realistic drawers across the three phases (ps>.05). Therefore drawing performance did not increase within the individual over the year of assessment.

Fisher tests however showed that although there were no differences between cohort 1 at Phase 3 and cohort 2 at Phase 1 (both intellectually realistic), there were significant increases in visual realism between cohort 2 at Phase 3 and cohort 3 at Phase 1 (Fisher Exact Test p<.001 and p<.01 for the cup and ball tasks respectively). Therefore the transition from intellectually to visually realism occurred between six years one month and six years eleven months. However this was not assessed within an individual because of the problem of cohort 3 being older than would have been hoped.

Additionally, the attrition of visually realistic children from cohort 2 and the trend towards reduced proportions of intellectually realistic children from cohort 3, meant that cohort 2 may have appeared more intellectually realistic and cohort 3 more visually realistic than was actually the case. Therefore, this resulted in a large division in drawing development between these two cohorts. However these results do reflect those reported in the cross-sectional studies presented earlier.

TABLE 11.1 FREQUENCY OF DRAWINGS FOR EACH MODEL

MODEL/ COHORT	PHASE 1		PHASE 2		PHASE 3	
REALISM	Visual	Intellectual	Visual	Intellectual	Visual	Intellectual
BALL						
Cohort 1	1	9	1	10	0	12
Cohort 2	1	14	3	14	1	16
Cohort 3	8	5	9	5	10	4
CUP						
Cohort 1	3	6	2	10	1	10
Cohort 2	2	15	1	16	1	16
Cohort 3	9	5	12	2	11	3

11.2.1.2 ATTENTIONAL DATA

11.2.1.2.1 Number of looks

A 3 (cohort) x 3 (phase) x 2 (object) x 4 (look type) analysis of variance was performed on the number of times each child looked at the model in front of them. Due to unequal variances and the standard deviations being proportional to the means, a log(10) transformation was performed on the data.

The ANOVA showed a significant main effect of cohort ($F(2,40)=6.03$ $p<.01$). Cohort 3 looked at the model more frequently than the younger two cohorts (Scheffe $ps<.05$). The ANOVA also showed that there was no significant main effect of phase ($F(2,75)=2.26$ $p>.05^{*}$), although there was a significant interaction between cohort and phase ($F(4,75)=3.07$ $p<.05^{*}$). Follow-up analysis of the means in Table 11.2 revealed that there were no significant differences between the cohorts at Phases 1 and 3, however cohort 2 looked significantly less at the models than cohort 3 at Phase 2 (Scheffe $p<.05^{*}$).

There was a significant interaction between cohort, phase, object and look type ($F(9,184)=2.67$ $p<.01^{*}$). Although follow-up analysis showed that there were no significant differences between individual means using Scheffe's method of follow-up analysis, cohort 3 did show trends towards high levels of 'within' looking particular for the cup model and particularly for Phases 2 and 3. Cohort 2 also showed increased 'within' looking at Phase 1, but to a lesser extent than cohort 3.

Between subjects analyses of variance showed that there were no significant differences between cohort 1 at Phase 3 and cohort 2 at Phase 1, or between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to their attention to the models ($ps>.05$).

11.2.1.2.2 Looking Time

A 3 (cohort) x 3 (phase) x 2 (object) x 4 (look type) analysis of variance was performed on the time each child spent looking at the model in front of them. Due to unequal variances and the standard deviations being proportional to the means, a log(10)

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 11.2 MEAN NUMBER OF LOOKS PER COHORT AND PHASE

COHORT	N	PHASE 1	PHASE 2	PHASE 3	MEAN TOTAL
COHORT 1	12	0.12 (0.50)	0.11 (0.46)	0.15 (0.58)	**0.13 (0.51)**
COHORT 2	17	0.15 (0.60)	0.11 (0.40)	0.14 (0.53)	**0.13 (0.51)**
COHORT 3	14	0.15 (0.57)	0.19 (0.76)	0.18 (0.77)	**0.18 (0.70)**
MEAN TOTAL		**0.14 (0.56)**	**0.14 (0.54)**	**0.16 (0.63)**	

Untransformed means (number of looks) are shown in parentheses.

transformation was performed on the data.

Like the Number of Looks measure, this ANOVA showed a significant main effect of cohort ($F(2,40)=7.75$ $p<.01$). Follow-up analysis showed that cohort 3 spent more time looking at the model than the younger two cohorts (Scheffe $ps<.05$). There was no significant main effect of phase ($F(2,77)=0.34$ $p>.05$*), although there was a significant interaction between cohort and phase ($F(4,77)=5.22$ $p<.01$*). Follow-up analysis of the means in Table 11.3, showed that cohorts 1 and 2 spent significantly less time looking at the models than cohort 3 at Phase 2 only (Scheffe $ps<.05$*). There were no significant age differences for Phases 1 and 3. See Figure 11.1 for an illustration of this effect.

Between subjects analyses of variance showed that there were no significant differences between cohort 1 at Phase 3 and cohort 2 at Phase 1, or between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to their attention to the models ($ps>.05$).

11.2.1.3 STRATEGIES OF ATTENTION

Based on the children's strategic attention towards the drawing model, they were divided into three categories i.e. exhaustively strategic, limited strategic and non-strategic according to the criteria previously detailed in Chapter 8, section 1.5. Friedman tests were used to compare each child's strategic development across phases, separately for each cohort and model, the results of which are shown in Table 11.4. Cohorts 1 and 3 showed no significant differences between the three phases for either drawing model ($ps>.05$), with cohort 1 being generally non-strategic and cohort 3 generally extensively strategic. Cohort 2 showed a significant difference for the cup model ($F_r=6.13$ d.f.=2 $p<.05$), although there were no differences between individual phases at follow-up. As Table 11.4 shows, this cohort seem to have been more strategic at Phase 1.

Fisher Exact Probability tests showed that there were no significant differences between cohort 1 at Phase 3 and cohort 2 at Phase 1, or between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to the attentional strategy that they used ($ps>.05$).

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 11.3 **MEAN LOOKING TIME PER COHORT AND PHASE**

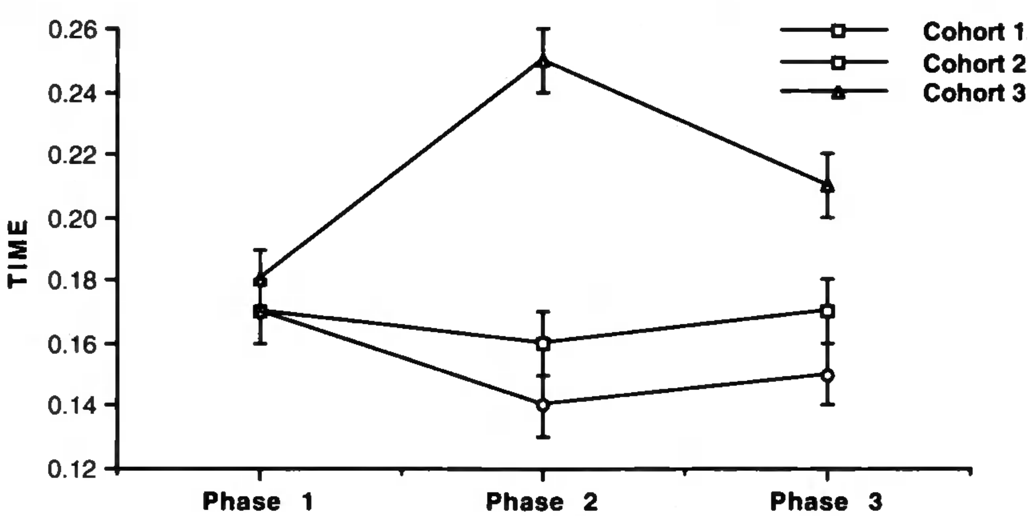
COHORT	N	PHASE 1	PHASE 2	PHASE 3	MEAN TOTAL
COHORT 1	12	0.17 (0.84)	0.16 (0.77)	0.17 (0.80)	**0.17 (0.81)**
COHORT 2	17	0.17 (0.87)	0.14 (0.71)	0.15 (0.65)	**0.16 (0.74)**
COHORT 3	14	0.18 (0.81)	0.25 (1.27)	0.21 (1.00)	**0.21 (1.03)**
MEAN TOTAL		**0.17 (0.84)**	**0.18 (0.92)**	**0.18 (0.82)**	

Untransformed means (seconds) are shown in parentheses.

TABLE 11.4 **FRIEDMAN TESTS FOR COMPARISON OF STRATEGIC ATTENTION BETWEEN PHASES**

COHORT/ MODEL	N	SUM OF RANKS PHASE 1	PHASE 2	PHASE 3	F_r	D.F.	P.
Cohort 1	12						
Ball		21.5	25.5	25.0	1.152	2	n.s.
Cup		25.0	20.0	27.0	3.059	2	n.s.
Cohort 2	17					2	
Ball		38.5	31.5	32.0	2.652	2	n.s.
Cup		40.0	28.0	34.0	6.128	2	<0.05
Cohort 3	14					2	
Ball		30.0	27.0	27.0	0.750	2	n.s.
Cup		23.5	31.5	29.0	3.350	2	n.s.

FIGURE 11.1 **INTERACTION OF COHORT BY PHASE FOR NUMBER OF LOOKS MEASURE**



11.2.1.4 META-AWARENESS QUESTIONS

Cochran tests were used to assess whether there were any significant changes across the three phases, in the children's responses to the question of whether they thought they would be able to draw the models even if they were hidden from view or not. Table 11.5 details the number of children giving each response for each phase, model and cohort. Cohorts 2 and 3 showed no significant differences across phases (ps>.05), with the majority of children responding with "yes". Cohort 1 showed a significant difference for the ball model ($Q=6.50$ d.f.=2 $p<.05$), although there were no differences between individual phases using a Binomial follow-up test. As Table 11.5 shows, there was a gradual progression towards the majority of children responding with "yes".

Fisher Exact Probability tests showed that there were no significant differences between cohort 1 at Phase 3 and cohort 2 at Phase 1, or between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to their "yes/no" responses (ps>.05).

Table 11.6 details the Friedman test analyses of the awareness categories. These were based on the children's justifications of why they thought they would still be able to draw the models or not. Cohorts 1 and 3 showed no significant differences between the three phases for either drawing model (ps>.05), with the majority of these children showing limited awareness of the attentional strategy. However Cohort 2 showed a significant difference for the ball model ($F_r=7.23$ d.f.=2 $p<.05$), although there were no differences between individual phases at follow-up. As shown in Table 11.6, this age group showed a trend towards higher awareness of the attentional strategy at Phase 3, although this was still only limited awareness.

Fisher Exact Probability tests showed that there were no significant differences between cohort 1 at Phase 3 and cohort 2 at Phase 1, or between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to their awareness of the attentional strategy (ps>.05).

TABLE 11.5 COCHRAN TESTS FOR COMPARISON OF YES/NO META-AWARENESS RESPONSES BETWEEN PHASES

COHORT/ MODEL/ RESPONSE	N	NUMBER OF SUBJECTS GIVING EACH RESPONSE			COCHRAN TESTS		
		PHASE 1	PHASE 2	PHASE 3	Q	D.F.	P.
Cohort 1	12						
Ball Yes		8	11	12			
No		4	1	0	6.500	2	<0.05
Cup Yes		8	10	10			
No		4	2	2	1.143	2	n.s.
Cohort 2	17						
Ball Yes		16	17	16			
No		1	0	1	1.000	2	n.s.
Cup Yes	16*	14	16	16			
No		2	0	0	4.000	2	n.s.
Cohort 3	14						
Ball Yes		13	12	13			
No		1	2	1	0.667	2	n.s.
Cup Yes		14	14	12			
No		0	0	2	4.000	2	n.s.

* One subject did not make a choice.

TABLE 11.6 FRIEDMAN TESTS FOR COMPARISON OF DRAWING AWARENESS BETWEEN PHASES

COHORT/ MODEL	N.	SUM OF RANKS PHASE 1	PHASE 2	PHASE 3	F_r	D.F.	P.
Cohort 1	12						
Ball		20.5	23.5	28.0	5.429	2	n.s.
Cup		22.0	23.5	26.5	2.333	2	n.s.
Cohort 2	17					2	
Ball		32.0	30.0	40.0	7.226	2	<0.05
Cup		32.0	34.0	36.0	0.727	2	n.s.
Cohort 3	14					2	
Ball		28.5	29.0	26.5	0.389	2	n.s.
Cup		29.5	28.0	26.5	0.500	2	n.s.

Summary of Main Findings

1: There was no significant change in individual drawing performance between the three phases. However there was a significant increase in visual realism between cohort 2 at Phase 3 (6:1 years) and cohort 3 at Phase 1 (6:11 years).

2: There was no overall increase in attention towards the drawing models between phases. However, cohort 3 showed higher levels of attention than the younger two groups, particularly at Phase 2.

3: There was no significant change in strategic attentional categories across phases.

4: The majority of children at all three phases believed that they would be able to draw the models even if they were hidden from view while they actual drew them.

5: All three cohorts showed limited awareness of the attentional strategy, with cohort 2 showing an increase in this awareness across phases.

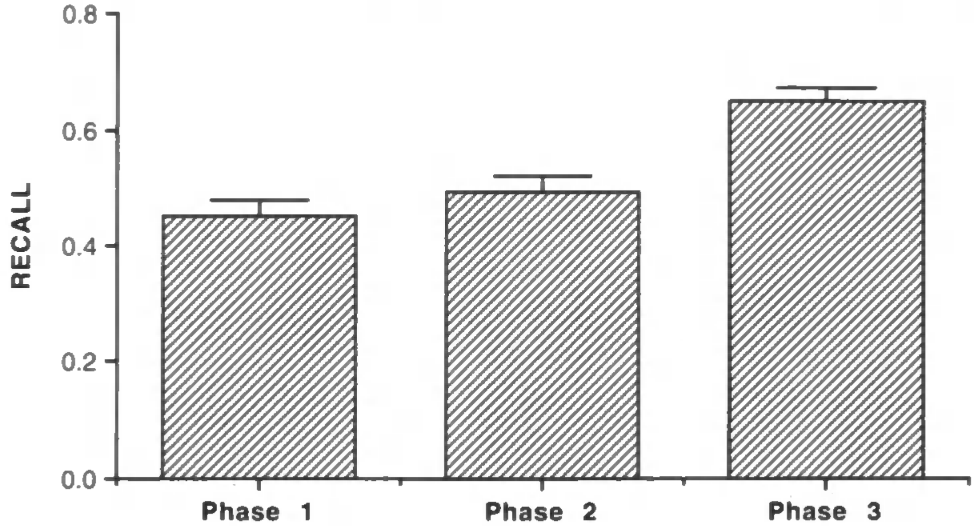
11.2.2 MEMORY TASK

11.2.2.1 RECALL RESPONSES

A 3 (cohort) x 3 (phase) x 2 (display type) analysis of variance was performed on each child's recall scores. Due to unequal variances and a narrow range of scores, the number of correctly recalled cards was divided by the total number possible i.e. twelve, and an arcsine transformation performed on this proportional score. This revealed a significant main effect of cohort ($F(2,40)=20.85$ $p<.001$). Scheffe follow-up analysis showed that cohort 3 recalled more items than the younger two cohorts ($ps<.001$). The mean number of cards recalled out of a possible twelve were 4.10, 4.97 and 7.27 for cohorts 1, 2 and 3 respectively. The ANOVA also show a significant main effect of phase ($F(2,72)=5.52$ $p<.01$*), in that a greater number of cards were recalled at Phase 3 compared to the earlier two phases. The mean number of cards recalled were 4.97, 5.36 and 6.01 for Phases 1, 2 and 3 respectively. This factor did not interact with cohort ($F(4,72)=1.57$ $p>.05$) suggesting that this pattern of results was evident for all three cohorts. See Figure 11.2 for an illustration of the main effect of phase.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

FIGURE 11.2 MAIN EFFECT OF PHASE FOR MEMORY RECALL SCORES



The ANOVA showed a significant main effect of display type ($F(1,40)=29.34$ $p<.001$), in that the grouped display type led to significantly more pictures being recalled than the mixed display type (mean number of cards recalled = 6.04 and 4.85 respectively). Although this factor did not interact with phase ($F(2,68)=1.06$ $p>.05$*), it did interact with cohort ($F(2,40)=11.34$ $p<.001$). Follow-up analysis revealed that increased recall for the grouped display type was only evident for cohort 3 (Scheffe $F(2,40)=48.91$ $p<.001$). Therefore only cohort 3 consistently benefited from the grouped display type across all phases.

Between subjects analyses of variance showed that there were no significant difference between cohort 1 at Phase 3 and cohort 2 at Phase 1 with regard to their recall performance ($F(1,27)=0.32$ $p>.05$). However there was a significant difference between cohort 2 at Phase 3 and cohort 3 and Phase 1 ($F(1,29)=6.68$ $p<.05$), in that cohort 3 recalled more items than cohort 2 (mean number of cards recalled = 7.21 and 5.68 respectively). There was also a significant interaction between cohort and display type ($F(1,29)=7.10$ $p<.05$) which showed that this effect was only evident for the grouped display type.

11.2.2.2 ARC CLUSTERING

A 3 (cohort) x 3 (phase) x 2 (display type) analysis of variance was performed on each child's ARC clustering scores. Due to unequal variances and a proportional score an arcsine transformation was performed on the data. If the child's ARC score was 'undefined' at any phase, they were removed from the analysis, this therefore resulting in low subject numbers particularly for cohort 1 were only one subject was available for analysis. The ANOVA showed a significant main effect of phase ($F(1,25)=4.28$ $p<.05$*), in that greater clustering of cards was evident at Phase 3 compared to the earlier two phases (Scheffe $ps<.05$). The mean clustering scores were 0.02, 0.21 and 0.59 for Phases 1, 2 and 3 respectively. This factor did not interact with cohort ($F(3,25)=2.52$ $p>.05$*) suggesting that this pattern of results was evident for all three cohorts.

*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

The ANOVA showed a significant main effect of display type ($F(1,17)=18.05$ $p<.01$), in that the grouped display type led to significantly more clustering than the mixed display type (mean clustering scores = 0.54 and 0.01 respectively). This factor significantly interacted with cohort and phase ($F(3,29=3.27$ $p<.05^*$). Follow-up analysis revealed that, for the grouped display type at Phase 1, cohort 3 showed significantly more clustering than cohort 1 (Scheffe $F(3,29=82.74$ $p<.01^*$). However this was based on the data from only one subject in cohort 1. There were no significant differences between cohorts for the other two phases (Scheffe ps>.05). Table 11.7 details the means for this interaction.

Between subjects analyses of variance showed that there were no significant differences between cohort 1 at Phase 3 and cohort 2 at Phase 1, or between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to their ARC clustering scores (ps>.05).

11.2.2.3 CLUSTERING CATEGORIES

Based on their ARC scores the children were divided into three categories i.e. exhaustively strategic, limited strategic and non-strategic. Friedman tests were used to compare each child's strategic development across phases, separately for each cohort and display type, the results of which are shown in Table 11.8. If the child's ARC score was 'undefined' at any phase, they were removed from the analysis. All three cohorts showed no significant differences between the three phases for either display type (ps>.05). The majority of cohort 1 were undefined (resulting in low subject numbers in the analysis), and both cohorts 2 and 3 showed limited clustering with the mixed display type and more extensive clustering with the grouped display type, across phases.

Fisher Exact Probability tests showed that there were no significant differences between cohort 1 at Phase 3 and cohort 2 at Phase 1, or between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to their clustering category (ps>.05).

11.2.2.4 META-MEMORY QUESTIONS

Cochran tests were used to assess whether there were any significant changes across the

TABLE 11.7 **MEAN ARC CLUSTERING SCORES PER COHORT, PHASE AND DISPLAY TYPE**

COHORT	DISPLAY TYPE	N	PHASE 1	PHASE 2	PHASE 3
Cohort 1	Mixed	1	-0.25 (-0.25)	-1.57 (-1.00)	1.57 (1.00)
	Grouped	1	-1.57 (-1.00)	1.57 (1.00)	1.57 (1.00)
Cohort 2	Mixed	8	0.22 (0.14)	0.11 (0.11)	0.01 (0.07)
	Grouped	8	0.84 (0.60)	0.39 (0.30)	0.76 (0.59)
Cohort 3	Mixed	11	-0.13 (-0.08)	0.15 (0.14)	-0.04 (0.00)
	Grouped	11	1.05 (0.73)	1.00 (0.72)	1.34 (0.91)
MEAN TOTAL			**0.02** **(0.02)**	**0.28** **(0.21)**	**0.87** **(0.59)**

Untransformed means (ARC scores) are shown in parentheses.

TABLE 11.8 **FRIEDMAN TESTS FOR COMPARISON OF STRATEGIC CLUSTERING BETWEEN PHASES**

COHORT/ DISPLAY	N	SUM OF RANKS PHASE 1	PHASE 2	PHASE 3	F_r	D.F.	P.
Cohort 1	3						
Mixed		6.5	5.0	6.5	0.667	2	n.s.
Grouped		5.5	9.0	9.5	3.800	2	n.s.
Cohort 2	17					2	
Mixed		19.0	17.5	17.5	0.250	2	n.s.
Grouped		23.5	19.5	23.0	2.000	2	n.s.
Cohort 3	14					2	
Mixed		22.0	22.5	21.5	0.071	2	n.s.
Grouped		26.5	25.0	32.5	5.250	2	n.s.

three phases in the children's choice of which arrangement would help them to remember the cards more. Table 11.9 details the number of children giving each response for each phase and cohort. Cohort 1 showed no significant difference across phases ($Q=2.00$ d.f.$=2$ $p>.05$), with the majority of children not being able to give any choice, therefore resulting in low subject numbers in the analysis. Cohort 2 showed a significant difference ($Q=6.25$ d.f.$=2$ $p<.05$), although post hoc Binomial tests did not reveal any differences between individual phases. As shown in Table 11.9, this cohort showed a trend towards a higher proportion of children selecting the mixed arrangement at Phase 1 compared to the other two phases. Cohort 3 also showed a significant difference ($Q=18.50$ d.f.$=2$ $p<.001$), with Binomial follow-up tests showing a greater proportion of children correctly selected the grouped arrangement at Phases 2 and 3 compared to Phase 1.

Fisher Exact Probability tests showed that although there was no significant difference between cohort 1 at Phase 3 and cohort 2 at Phase 1, there was a significant difference between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to their choice of arrangement (Fisher Exact Test $p<.001$). This showed that a greater proportion of cohort 2 selected the grouped arrangement at Phase 3, while cohort 3 selected the mixed arrangement at Phase 1, therefore illustrating a practice or exposure effect.

Table 11.10 details the Friedman test analyses of the awareness categories. These were based on the children's justifications of why they thought the arrangement they had selected would aid their recall. All three cohorts showed no significant differences between the three phases (ps>.05), with the majority of cohort 1 showing no awareness, cohort 3 showing extensive awareness and cohort 2 showing combinations of all three levels of awareness, across phases.

Fisher Exact Probability tests showed that there were no significant differences between cohort 1 at Phase 3 and cohort 2 at Phase 1, or between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to their awareness of the clustering strategy (ps>.05).

TABLE 11.9 **COCHRAN TESTS FOR COMPARISON OF MIXED/GROUPED META-AWARENESS RESPONSES BETWEEN PHASES**

COHORT/ RESPONSE	N *	NUMBER OF SUBJECTS GIVING EACH RESPONSE			COCHRAN TESTS		
		PHASE 1	PHASE 2	PHASE 3	Q	D.F.	P.
Cohort 1	3						
Mixed		1	2	1			
Grouped		2	1	2	2.000	2	n.s.
Cohort 2	12						
Mixed		7	2	2			
Grouped		5	10	10	6.250	2	<0.05
Cohort 3	14						
Mixed		12	1	2			
Grouped		2	13	12	18.500	2	<0.001

* Only those subjects giving either a grouped or a mixed response at all three phases were included in the analysis.

TABLE 11.10 **FRIEDMAN TESTS FOR COMPARISON OF MEMORY AWARENESS BETWEEN PHASES**

COHORT	N	SUM OF RANKS PHASE 1	PHASE 2	PHASE 3	F_r	D.F.	P.
Cohort 1	12	21.5	23.0	27.5	5.200	2	n.s.
Cohort 2	17	31.5	36.5	34.0	1.250	2	n.s.
Cohort 3	14	26.0	29.0	29.0	0.750	2	n.s.

Summary of Main Findings

1: There was a significant increase in recall performance at Phase 3, for each cohort. However there was a significant increase in recall between cohort 2 at Phase 3 (6:1 years) and cohort 3 at Phase 1 (6:11 years) for the grouped display type.

2: There was a significant increase in clustering of recall items at Phase 3, for each cohort.

3: There was no significant change in strategic clustering between phases when the children's ARC clustering scores were divided into strategic categories.

4: Cohort 3 and to some extent Cohort 2, showed a significant change from selecting the mixed arrangement as an aid to recall at Phase 1, to selecting the grouped arrangement at Phases 2 and 3. Additionally, cohort 2 at Phase 3 (6:1 years) selected the grouped arrangement, while cohort 3 at Phase 1 (6:11 years) selected the mixed arrangement.

5: There was no significant change in awareness of the clustering mnemonic across phases.

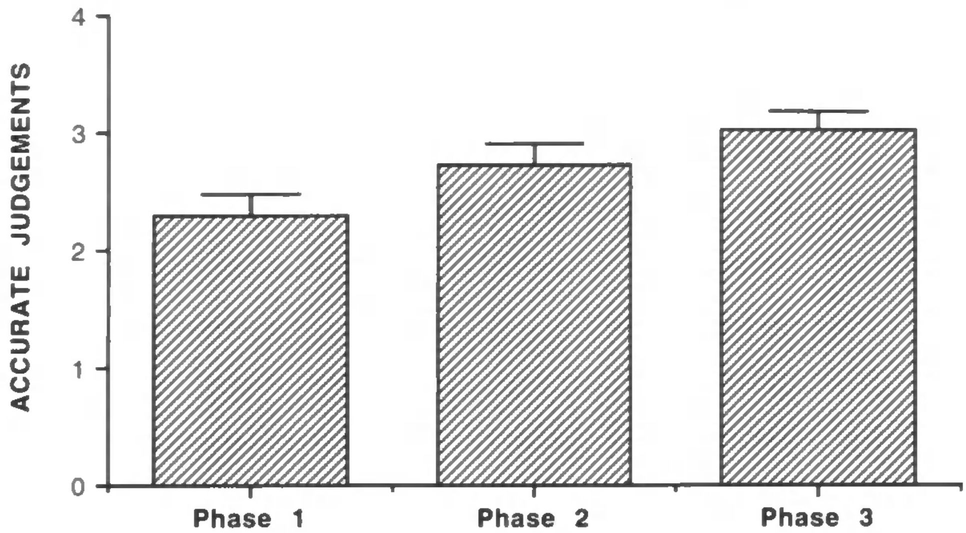
11.2.3 SELECTIVE ATTENTION TASK

11.2.3.1 TOTAL NUMBER OF ACCURATE JUDGEMENTS

A 3 (cohort) x 3 (phase) analysis of variance was performed on the total number of accurate judgements of whether the house pairs were the same or different. Due to equal variances and a normal distribution no transformation was necessary. The ANOVA showed a significant main effect of cohort ($F(2,40)=20.73$ $p<.001$), where cohort 3 accurately judged more house pairs than cohort 1. The mean number of accurate judgements out of four were 1.92, 2.61 and 3.43 for cohorts 1, 2 and 3 respectively. The ANOVA also showed a significant main effect of phase ($F(2,70)=6.91$ $p<.01$*), in that the children made more accurate judgements at Phase 3 than they did at Phase 1. The mean number of accurate judgements were 2.30, 2.72 and 3.02 for Phases 1, 2 and 3 respectively. See Figure 11.3 for an illustration of this effect. This factor did not interact with cohort

*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE 11.3 MAIN EFFECT OF PHASE FOR THE TOTAL NUMBER OF ACCURATE JUDGEMENTS FOR THE SELECTIVE ATTENTION TASK



($F(3,70)=0.78$ $p>.05^{*}$) suggesting that this pattern of results was evident for all three cohorts. Between subjects analyses of variance showed that there were no significant differences between cohort 1 at Phase 3 and cohort 2 at Phase 1, or between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to ability to accurately differentiate the house pairs (ps>.05).

11.2.3.2 WINDOW OPENING STRATEGIES

In order to assess whether the children's window opening strategies varied across phases, Friedman tests were performed on the most predominant strategy used by each child across the four house pairs. All three cohorts showed no significant differences between phases (ps>.05). Cohort 1 generally used a limited strategy, cohort 2 either a limited or an exhaustive strategy, and cohort 3 an exhaustive strategy, across all three phases. The results of this analysis are shown in Table 11.11.

Fisher Exact Probability tests showed that although there was no significant difference between cohort 2 at Phase 3 and cohort 3 and Phase 1, there was a significant difference between cohort 1 at Phase 3 and cohort 2 at Phase 1 with regard to their window opening strategies (Fisher Exact Test $p<.05$). A greater proportion of cohort 1 used limited window opening strategies at Phase 3, while cohort 2 used exhaustive strategies at Phase 1.

11.2.3.3 META-AWARENESS QUESTIONS

In order to assess whether the children's awareness categories, i.e. their justifications of why the house pairs were the same or different, varied across phases, Friedman tests were performed on the most predominant awareness category shown by each child across the four house pairs. The results of this analysis are shown in Table 11.12. Cohorts 2 and 3 showed no significant differences between phases (ps>.05), with the majority of cohort 3 showing extensive awareness, and cohort 2 showing either limited or extensive awareness, across pairs. Cohort 1 did show a significant difference ($F_r=6.73$ d.f.=2 $p<.05$), although there were no differences between individual phases at follow-up. As shown in Table 11.12 these children showed a trend towards increasing awareness across

TABLE 11.11 **FRIEDMAN TESTS FOR COMPARISON OF STRATEGIC WINDOW OPENING BETWEEN PHASES**

COHORT	N	SUM OF RANKS PHASE 1	PHASE 2	PHASE 3	F_r	D.F.	P.
Cohort 1	12	20.5	24.5	27.0	3.440	2	n.s.
Cohort 2	17	34.5	30.5	37.0	3.071	2	n.s.
Cohort 3	14	25.0	28.0	31.0	3.429	2	n.s.

TABLE 11.12 **FRIEDMAN TESTS FOR COMPARISON OF SELECTIVE ATTENTION AWARENESS BETWEEN PHASES**

COHORT	N	SUM OF RANKS PHASE 1	PHASE 2	PHASE 3	F_r	D.F.	P.
Cohort 1	12	18.5	24.5	29.0	6.727	2	<0.05
Cohort 2	17	30.5	32.5	39.0	3.854	2	n.s.
Cohort 3	14	26.0	29.5	28.5	3.714	2	n.s.

the three phases, with 75% of them showing no awareness at Phase 1 and 50% showing extensive awareness by Phase 3. Fisher Exact Probability tests showed that there were no significant differences between cohort 1 at Phase 3 and cohort 2 at Phase 1, or between cohort 2 at Phase 3 and cohort 3 and Phase 1 with regard to their justifications of why the house pairs were the same or different (ps>.05).

Summary of Main Findings

1: There was a significant increase in ability to accurately differentiate the house pairs at Phase 3, for each cohort.

2: There was no significant change in strategic window opening between phases. However there was a significant improvement in strategy use between cohort 1 at Phase 3, who used limited strategies, and cohort 2 at Phase 1 who used exhaustive strategies.

3: Although cohorts 2 and 3 showed no significant change in awareness, cohort 1 showed a gradual increase in awareness between phases.

11.3 DISCUSSION

The longitudinal analysis resulted in only a few significant increases in individual performance across the three phases of assessment. This was possibly due to the low subject numbers as a result of the high attrition rate particularly from cohort 1. Additionally, there was the problem of many of the dependent variables being categorical and therefore only non-parametric statistical tests could be used, and these measures often lacked sensitivity in their ability to differentiate between different levels of performance. Some significant differences were however evident between the separate cohorts i.e. between cohort 1 at Phase 3 (four years eleven months) and cohort 2 at Phase 1 (five years one month), and between cohort 2 at Phase 3 (six years one month) and cohort 3 at Phase 1 (six years and eleven months). The significant differences between cohorts 2 and 3 were possibly the result of the increased age difference between these two age groups.

11.3.1 DRAWING TASK

For the drawing task the transition from intellectual to visual realism occurred between six years one month and six years eleven months. However this was assessed between two separate cohorts and therefore the transition was unfortunately not witnessed within the individual over the year of assessment. Cohorts 1 and 2 were consistently intellectually realistic across phases while cohort 3 was consistently visually realistic. Ideally if cohort 3 had been six years and one month at Phase 1 they might possibly have shown similar performance to cohort 2 at Phase 3 (intellectual realism). By Phase 2 (six years seven months) they then might have been expected to show fairly equal proportions of intellectual and visual realism, progressing to a higher proportion of visual realism at Phase 3 (seven years one month). A transitional phase of roughly equal levels of both types of drawings was to some extent evident in cohort 3 at Phase 1 (including all the original twenty subjects) when the subjects were six years eleven months i.e. 64% were visually realistic and 36% intellectually realistic, as opposed to 86% and 14% respectively at Phase 2 for the cup model. Therefore if this cohort had been assessed at the ages mentioned above this transitional phase would possibly have been even more evident at the younger age of six years and seven months. However as mentioned above 86% of cohort 3 were visually realistic at Phase 2 (aged seven years and five months). If the longitudinal study had finished with children aged just seven years one month, they may never have shown the progression to this level of performance and remained at the transitional phase.

An additional problem for the drawing data was the significant attrition of visually realistic children from cohort 2 and the trend towards reduced proportions of intellectually realistic children from cohort 3. This therefore increased the divisions between these two cohorts that had already been produced by the increased age difference. Cohort 2 appeared to be more intellectually realistic, and cohort 3 more visually realistic than was actually the case. It was therefore difficult to draw any firm conclusion about the developmental transition from intellectual to visual realism. However it seems safe to conclude that it occurs between six and seven years of age, confirming the findings of the cross-sectional studies detailed in Chapters 2 to 5.

Age differences in the amount of attention paid by the children towards the two drawing models were only evident at Phase 2. The younger two cohorts showed fairly high levels of looking at Phase 1 which then reduced (although not significantly) at Phase 2, while cohort 3 showed the opposite pattern, i.e. an increase in attention at Phase 2. It is possible that the familiarity of the task at Phase 2 (it was noted by the experimenter that the children remembered that the two drawing models were a cup and two balls) led to reductions in the attention of the younger children. Cohort 3 however was becoming more strategic as it got older (between six years eleven months and seven years five months) and attention increased. Consistent with this was the trend towards increased looking 'within' drawing separate elements of the cup model for cohort 3 at Phase 2, and to a lesser extent at Phase 3. Therefore these children were relatively non-strategic in their attentional behaviour at Phase 1 (six years eleven months), then progressed to using a more extensive strategy at Phase 2 (seven years five months), particularly for a model that required additional attention in order to accurately represent its shape, and finally to reduced attention at Phase 3 (seven years eleven months) presumably due to the simplicity of the tasks. This pattern is consistent with the behaviour of the six- and eight-year-olds in the cross-sectional studies.

The increased attention of cohort 2 at Phase 1 was also evident with the analysis of strategic attentional categories for the cup model at least. Fifty-three percent of them used an extensive strategy (high levels of 'within' and/or 'between' looking) at Phase 1, while 76% and 53% of them were non-strategic at Phases 2 and 3 respectively. It is possible that the novelty of the task led to increased attention initially. This then reduced at the next two testing phases because the children 'knew' that the task involved them drawing a cup and two balls. This could therefore have added to the increased levels of intellectual realism for this age group as the children were not referring to the actual models. Additionally, if the children were including the handle on the cup in their drawing, their looking 'between' drawing separate elements of the model could increase and therefore result in being classified as extensively strategic. If the child had produced a visually realistic drawing there would only have been one element i.e. the body of the cup, and therefore 'between' looking would not have been applicable, only 'within'. It would therefore have been preferable to have a more stringent scoring procedure, however this did only apply to three children, and therefore this still resulted in 30% of this cohort showing high levels of 'within' looking even at this young age.

Extensive awareness of the attentional strategy in young children was generally not evident, as a large proportion of children from all three cohorts only showed limited awareness e.g. they described the model or were confident in their ability to draw it. Consistent with this, the majority of children in all three cohorts and at all three phases, were confident in their ability to draw the models even if they were hidden from view while they actually drew them. This was not surprising considering that the models were fairly simple and very familiar to the children. Being classified as having extensive awareness involved mentioning the necessity of attending to the model. However, it is possible that this behaviour was to a large extent subconscious, especially considering that total attention paid to a model during the task averaged about 0.8 of a second, therefore individual looks could have been considerably less, depending on the number of looks that the child makes. Additionally, metacognitive assessment in young children is often problematic as it is quite possible that the children are unable to verbalise the basis of their behaviour (Miller & Weiss, 1981). Therefore it was not surprising that the majority of responses to the meta-awareness question just involved describing the models, or stating that they would still be able to draw the models "because I can". The children knew what the model was and had confidence in their own abilities to draw it. These children had not made the link between these factors and the necessity of attending to the model in order to know what the model was and what it actually looked like from their viewing position.

11.3.2 MEMORY TASK

Unlike drawing performance, memory recall performance did increase within the individual across the three phases. Although cohort 3 was consistently recalling more items at each phase, there was an increase in the number of cards recalled at Phase 3 for all three cohorts. Therefore, even though cohorts 1 and 2 were not generally benefiting from the categorical grouping of the cards at encoding, they did improve their recall ability. This was possibly due to the familiarity with the task or general increases in memory capacity. However there was a corresponding increase in the amount of clustering of the items in the recall protocol at Phase 3. Analysis of the individual phases resulted in no relationship between increased clustering and increased recall at Phase 1 and 2, but did find such a relationship for Phase 3 with the grouped display type. This was therefore consistent with the analysis across phases, in that Phase 3 showed increases in both recall and clustering compared to the other two phases. However it must be noted that this analysis was based on the data from only one subject in cohort 1 whose ARC clustering scores could be calculated at all three phases.

Cohort 3 showed superior recall ability throughout the study due to the benefit that they gained from using the clustering strategy, particularly when this was prompted by the grouped display of the cards at encoding. There was therefore a significant increase in recall performance with the grouped display type between cohort 2 at Phase 3 and cohort 3 at Phase 1, i.e. between six years one month and six years eleven months. Therefore like drawing performance, it was unfortunate that this increase in ability was not observed within the individual, but instead between cohorts 2 and 3.

For cohorts 2 and 3 the awareness of the mnemonic strategy of clustering items improved between Phase 1, where all cohorts generally selected the mixed arrangement as an aid to recall, and Phases 2 and 3, were they correctly selected the grouped arrangement. There was therefore a significant decline in performance between cohort 2 at Phase 3 and cohort 3 at Phase 1. Cohort 1 showed no increase in ability to select the correct arrangement across phases. Therefore after the age of five, children begin to develop an awareness of how the arrangement of cards at encoding can affect recall ability. This ongoing developmental process then appears to be revealed, or even accelerated, through repeated exposure to the task. Under the age of five this repeated exposure had no effect, with very few of these children being able to even understand the task.

Although cohort 2 showed an improvement in their tendency to select the grouped arrangement, there was no corresponding increase in ability to extensively justify why this would aid recall performance. Therefore this cohort showed only limited awareness of the clustering strategy and tended to justify their choice by referring to "remembering them more" or "because it's better". It was not until six years and eleven months that the children showed consistent extensive awareness of the clustering strategy by referring to the grouping of the cards.

11.3.3 SELECTIVE ATTENTION TASK

Although cohort 3 consistently showed increased ability to accurately differentiate the house pairs across phases, there was a significant increase in this ability for all three cohorts between Phases 1 and 3. Therefore like the memory task, this showed how repeated exposure to the task led to increases in performance. However the increased age of cohort 3 meant that they were already performing well even at Phase 1 (except to some extent with Pair 4). Therefore, like the drawing task, gradual individual development could not be adequately assessed.

This was also a problem with regard to the window opening strategies that the children used. These remained consistent within the individual across the three phases, although there were differences between the different cohorts. Cohort 1 used limited opening strategies, cohort 2 either limited or exhaustive, while cohort 3 consistently used an exhaustive window opening strategy across the three phases. This therefore resulted in a significant difference between cohort 1 at Phase 3 who were using limited strategies, and cohort 2 at Phase 1 who showed higher levels of exhaustive strategy use.

Similarly, for cohorts 2 and 3 there were no individual increases in their ability to adequately justify why the house pairs were the same or different, with cohort 2 showing either limited or extensive justifications and cohort 3 giving consistent extensive justifications. Cohort 1 did however show an increase in metacognitive awareness across phases. Seventy-five percent of the children at Phase 1, and 50% at Phase 2, showed no awareness of why the houses were the same or different, while 43% of them showed extensive awareness at Phase 3. Therefore again it seems that repeated exposure to the task reveals the ongoing developmental increase in metacognitive awareness. It was certainly noted by the experimenter that by Phase 3 the children were fully aware of this task and what they were required to do.

11.3.4 CONCLUSIONS

The study revealed no increase in individual children's ability to produce visually realistic drawings. For the younger children it seems that familiarity with the task led to a reduction in performance. The children knew that they had to draw a cup and two balls and therefore did not direct much attention to the models and how they were placed in front of them. Hence they continued to draw stereotypical representations. Cohort 3 however seemed to have reached a stage of development where they were becoming more strategic in their attention by Phase 2, and therefore showed higher levels of continuous attention to the model (revealed by increased 'within' and 'between' looking). However, by Phase 3 this behaviour had reduced, possibly due to the simplicity of the tasks, and so this cohort now appeared capable of drawing the models without continued attention to them. This result was consistent with the findings of Studies 2 and 3 in that the eight-year-olds were not necessarily attending to the drawing models to any great extent, but were still able to produce visually realistic drawings.

With the memory and selective attention tasks, familiarity and practice seem to either reveal or possibly accelerate the children's developing abilities to perform cognitive tasks, use strategies and show metacognitive awareness. By Phase 3 the children were able to recall a large percentage of the cards, cluster the items at recall and were aware of the beneficial effects of clustering. Similarly, they were able to accurately differentiate the house pairs, use exhaustive window opening strategies and were able to provide extensive justifications of why the house pairs were the same or different. Therefore, although familiarity may have led to reductions in performance in the drawing task, for the memory and selective attention tasks it seems that familiarity and practice have helped the children to demonstrate their developing cognitive abilities and may even have accelerated their development.

It was unfortunate that many of the significant changes were occurring at the divisions between, and not within the individual cohorts. This was particularly the case for cohorts 2 and 3, where there was a greater age division between them than was initially planned. Many of the changes were occurring between six and seven years of age, while few were occurring between three and four. Therefore, it would have been preferable to have started the age groups at four years eight months, five years eight months and six years eight months. This would have meant that the changes that were occurring in the six-year-olds would have been covered by the older two cohorts i.e. between five years eight months and six years eight months, and between six years eight months and seven years eight months. This would therefore have solved the problem discussed in Section 11.3.1. If as suggested, cohort 3 had started the study at the age of six years and one month, i.e. one year older than cohort 2 instead of twenty-two months older, cohort 3 would only have reached seven years one month by Phase 3. Therefore, they may still have shown evidence of intellectual realism and not progressed to the majority of the group being visually realistic. By spanning the ages of four years eight months to seven years eight months this would hopefully have resulted in a more thorough assessment of individual development of these cognitive abilities.

CHAPTER 12

GENERAL DISCUSSION

This thesis has extended the children's drawing literature by employing alternative methodologies. Previous research, although providing descriptive accounts of the products of children's drawings, has not necessarily provided evidence of the mechanisms involved. The present research, by measuring the attention that children pay towards the drawing models and placing the development of drawing in a broader cognitive context, has not only replicated previous work, but also provided a new perspective with which to interpret the literature.

The contrast and instructional effects reported by Davis (1983) and Barrett, Beaumont & Jennett (1985) respectively, have been explained in terms of providing the child with a greater understanding of the task demands. The present research suggests that the children already have this understanding, but that they do not know how to approach the task effectively. Explicit instructions, by stressing attention to the model, may inadvertently equip the younger child with an effective strategy that subsequently leads to the production of visually realistic drawings (see Chapters 3 and 4). In the same way as the instructions stress attention, providing a contrast between the orientation of two models may prompt the child to increase their attention, in order to compare and contrast the two models (see Chapters 2 and 3).

Evidence is therefore provided of the possible mechanisms involved in effects that have been repeatedly described in the drawing literature. This research was then placed in a broader cognitive context, by assessing the development of drawing and strategic attention in relation to memory and selective attention abilities. This therefore allowed a more detailed interpretation of the mechanisms involved in general cognitive development (see Chapters 8 to 11).

The following sections will discuss in more detail the development of attentional strategies and their subsequent effect on children's drawing ability, and how these relate to strategic and metacognitive development in memory and selective attention.

12.1 ATTENTIONAL STRATEGIES AND DRAWING DEVELOPMENT

As discussed in Chapter 6, the cross-sectional studies suggested equivalent development between drawing performance and strategic attention to the drawing models. The four-year-olds, who generally produced intellectually realistic drawings, rarely looked at the model after the instructions had been given and once they had started to draw. The older children who produced more visually realistic drawings, tended to use the more beneficial strategy of continually attending to the model. Direct comparison between drawing performance and strategy use generally revealed that increased attention was associated with the production of a visually realistic drawing.

The use of these strategies was affected by the specific nature of the objects drawn, the instructions given and exposure to the model. Increased strategic attention was associated with more complex models and the explicit instructions prompted the children to use the strategy spontaneously employed by an older child. The four-year-olds therefore used the limited strategy of the six-year-olds, i.e. increased looking at the 'beginning' of the task. This strategy did not necessarily lead to the production of a visually realistic drawing, but was more beneficial than the strategy the four-year-olds spontaneously used, i.e. low levels of looking at the 'beginning' of the task. The six-year-olds were prompted by the explicit instructions to use the extensive attentional strategy employed spontaneously by the eight-year-olds, i.e. continued attention to the model while they actually drew. This strategy was far more likely to lead to the production of a visually realistic drawing.

The eight-year-olds were spontaneously strategic and therefore although they showed increased levels of attention in response to the explicit instructions, this was not necessary. This age group were capable of producing visually realistic drawings when they were presented with only standard instructions. However, denying them the possibility of using this strategy led to reductions in drawing performance. This was achieved by removing the model after the instructions had been given and before the child started to draw, therefore mimicking the strategy used by the younger intellectually realistic children. This therefore demonstrated a close link between the necessity of continued attention to the model and the subsequent production of a visually realistic drawing.

Although direct assessment of the attentional behaviour of the intellectually and the visually realistic drawers was undertaken, this did not always produce significant results. This was generally the result of the post hoc division of the subject groups into the two drawing categories. This meant that there was no control over the number of subjects in each group. Therefore, for the younger age groups there was a predominance of intellectually realistic drawers, and for the older groups a predominance of visually realistic drawers. This resulted in reducing the power of the statistical tests and therefore increasing the possibility of Type I errors. In Study 4 (Chapter 5) the link between drawing realism and attention to the model was specifically controlled by assigning equal numbers of subjects into the two exposure conditions, i.e. continuous and short exposure to the drawing models. Therefore it was possible to conduct a more powerful statistical assessment of the extent to which strategic attention was necessary to produce a visually realistic drawing.

The cross-sectional studies had therefore established a close link between the development of attentional strategies and drawing performance. The children progressed through three stages of strategic development from being, 1) non-strategic by only attending to the model briefly at the 'beginning' of the task, 2) using the limited strategy of increased attention at the 'beginning', and 3) using the extensive strategy of continued attention, i.e. looking 'within' and 'between' drawing separate elements of the model. It was suggested in Chapter 6 that this development was possibly linked to increasing metacognitive awareness of the necessity to attend to the model. For example, the six-year-olds have some awareness of the need to pay attention but are as yet unsure of the most effective way of doing this, they therefore only increase their 'beginning' looking when prompted by explicit instructions. These developmental patterns have not previously been assessed with reference to drawing performance, but similar patterns had been established for memory (Schneider & Sodian, 1988) and selective attention (Miller & Weiss, 1981). Children seem to initially show no strategic abilities or metacognitive awareness of these. They then develop to an intermediary level where they have some awareness and attempt to be more strategic. However, these strategies do not necessarily result in increased performance. Finally, they develop the use of extensive strategies that do result in performance benefits.

The longitudinal study therefore attempted to firstly confirm the development of strategic attention in relation to drawing performance within the individual. The cross-sectional studies could only assess this between different age groups. Secondly, it attempted to see whether children progressed through the same three stages of development in different cognitive tasks. Finally, by comparing the development of performance, strategy use and metacognitive awareness across drawing, memory and selective attention, it attempted to assess whether development was simultaneous or sequential.

12.2 INDIVIDUAL DEVELOPMENT

Confirmation of individual developments in drawing performance and strategic attention was not successfully achieved due to the significant changes occurring at the divisions between the cohorts, particularly cohorts 2 and 3 i.e. between six years one month and six years eleven months. Therefore the individual children tended to remain at the same level of drawing realism throughout the course of the study. Additionally, although the study resulted in data being collected from children ranging from three to eight years, the longitudinal component was only one year in duration and therefore comparatively short. Ideally, it would have been beneficial to extend this period in order to establish individual development.

However, cohort 3 did show some progression in drawing development. At Phase 1 when they were six years and eleven months, 36% of them produced intellectually realistic drawings. This was opposed to Phase 2 where only 14% of them were intellectually realistic. This cohort were therefore showing some progression from a transitional phase of both intellectual and visual realism, to the majority of the children producing visually realistic drawings. This transitional phase was however particularly evident when assessing the whole sample size at Phase 1, and not just those children who were available at all three phases. Looking at the two types of drawers in cohort 3 at Phase 1 detailed in Table 8.2, there were clearly equal proportions of intellectually and visually realistic drawers. This effect was therefore masked to a large extent by the attrition of intellectually realistic children from this cohort.

This increase in drawing performance for cohort 3 at Phase 2 coincided with a corresponding increase in their attention, particularly looking 'within' drawing separate elements of the cup model. They therefore adopted a more beneficial attentional strategy. In fact, the only cohort differences in the levels of attention were evident at this phase, i.e. cohort 3 attended to the model more than the younger two cohorts. At Phase 3, cohort 3 showed a reduction in attention, so that there was no overall difference in attention between the three cohorts. This was therefore consistent with the findings of the cross-sectional studies. Where the drawing models were simple, as in the case of the longitudinal study, the older children could produce a visually realistic drawing without employing the extensive strategy that they were quite capable of using.

Surprisingly, at Phase 1 when they were only five years and one month old, cohort 2 showed fairly high levels of 'within' looking, particularly for the cup model. Therefore they spontaneously adopted an extensive attentional strategy without any prompting from explicit instructions. This strategy was not particularly evident in cohort 3 until they were much older, i.e. seven years and five months. However as cohort 2 did not show this strategic behaviour at the following two phases, it was possible that the novelty of the task led to the effects found. As described in Chapter 11 Section 3.1, the children remembered that they had to draw a cup and two balls and therefore did not pay much attention to the models at Phases 2 and 3. However, this behaviour was not evident in the cross-sectional studies where the children were only tested on one occasion. As the cross-sectional studies involved much larger sample sizes than was possible in the longitudinal study, this effect may have been the result of a small, unrepresentative sample of five-year-olds.

Unlike the drawing task, the children showed individual improvements in both memory and selective attention. Memory recall performance, categorical clustering and the ability to differentiate the house pairs in the selective attention task, all increased at Phase 3. Therefore it seems that repeated exposure to these two tasks led to increased abilities. However, this repeated exposure seems to have had the reverse effect on the drawing task. As discussed above, at Phases 2 and 3 these children had remembered that they were required to draw a cup and two balls. They therefore did not take much notice of how these were specifically placed in front of them, i.e. with the cup's handle hidden from view and one ball partially occluding the other. This may therefore have led to the predominance of intellectually realistic drawings for the younger two cohorts.

Therefore individual increases in drawing performance and strategic attention were not particularly evident in the longitudinal study. However it must be noted that the longitudinal component was relatively short. Despite this, individual developments in memory and selective attention were observed over the one year assessment period. This would suggest some differences in the time scale of individual development between these three cognitive tasks. However, the attrition of intellectually realistic drawers from cohort 3 reduced the possibility of observing individual change for this task. In general, the children from cohort 3 who were available at Phases 2 and 3 were already visually realistic and therefore could not be shown to improve in performance. Thus, taking into account the effects of attrition, it does appear that development increased in each of the three tasks. The next step was to assess whether these children progressed through the same stages of development in drawing, memory and selective attention?

12.3 THE THREE STAGES OF DEVELOPMENT

As discussed earlier, the cross-sectional studies suggested three stages of strategic attention and drawing development, which may be linked to increasing metacognitive understanding of these strategies and how they effect performance. Previous literature would suggest that this pattern of development was also evident in memory and selective attention.

For the drawing task, the patterns of development established in the cross-sectional studies were generally confirmed. Cohort 1 were non-strategic in their attention, they produced intellectually realistic drawings and showed no awareness of the necessity of attending to the drawing models. Although cohort 2 were still producing intellectually realistic drawings they did show some limited strategy use and some awareness. In contrast, cohort 3 used more extensive strategies and were producing visually realistic drawings, although they still only showed limited awareness. However, as discussed previously, this was quite a subtle strategy that the children may not necessarily be aware of using. These results relate to spontaneous performance as only standard instructions were presented. It would be expected that higher strategic levels would have been evident if explicit instructions had been given. However, it is unknown whether metacognitive awareness of these strategies would have shown a corresponding increase.

Although the drawing task assessed spontaneous abilities, the memory task assessed both spontaneous and prompted strategic development. With the mixed display type spontaneous development was to some extent assessed, but was limited by the problems of repeated testing both within and between phases. It was quite probable that this repeated testing led the children to transfer their strategy use where it was prompted (grouped display type) onto the spontaneous condition (mixed display type). Despite these limitations the pattern of results was consistent with the drawing task. Cohorts 1 and 2 showed low levels of recall and low levels of clustering strategy for the mixed display type, but did show some extensive clustering with the grouped display type particularly at Phase 3. However this did not lead to increased recall ability. They were therefore responding to the prompt to use the strategy but this was not sufficient to lead to benefits in performance. Although cohorts 1 and 2 generally showed no awareness of the clustering strategy, there was a proportion of cohort 2 who did show some extensive awareness. Cohort 3 showed moderate levels of performance and were non-strategic with the mixed display type. However in contrast to the younger two cohorts, they showed consistent extensive clustering which led to increased recall performance and extensive awareness of this mnemonic strategy with the grouped display type.

For the selective attention task, higher levels of performance were established at an earlier stage of the study than for the other two tasks. As discussed previously, this was possibly due to the increased experience of this task. At Phase 1, cohort 1 showed little ability to differentiate the house pairs, they were either non-strategic or used a limited strategy and were unaware of the effectiveness of opening homologous windows. Cohort 2 showed moderate ability to differentiate the pairs, they used limited window opening strategies, but still showed no awareness. Cohort 3 showed high performance levels and limited strategy use but unlike the other two cohorts, they did show extensive awareness. At Phase 2 performance, strategy use and metacognitive awareness had increased in all three cohorts. By Phase 3 the majority of children could accurately differentiate the house pairs, were using the exhaustive window opening strategies and could extensively justify why the house pairs were the same or different. Therefore, repeated experience of this task may have led to an accelerated ability to complete the task accurately and efficiently, even though the strategy was not prompted in the same way as in the memory task. These results were consistent with DeMarie-Deblow & Miller (1988). They believe that the initial use of a strategy leads to a reduction in the processing capacity available to devote to task performance. However, with experience and practice of the tasks, the strategy becomes more automatic and less demanding and therefore results in increased selective attention ability.

The evidence therefore suggests that the developmental pattern in strategic attention and its relationship to drawing performance and metacognitive awareness, is similar to developments in memory and selective attention. A lack of strategic behaviour is associated with low performance levels and little metacognitive awareness. As the strategies begin to develop they do not necessarily lead to increased performance or awareness. Prompting these strategies or providing the children with increased experience of them seems to improve performance by possibly equipping the child to carry out the task more effectively. This pattern appears to be similar in drawing, memory and selective attention. However, this poses the question of whether development is simultaneous across tasks which would suggest general underlying abilities, or whether development is sequential which would suggest that children become strategic in certain tasks before they are strategic in others.

12.4 SIMULTANEOUS OR SEQUENTIAL DEVELOPMENT?

The longitudinal study supports the view that there is a general strategic ability or metacognitive understanding that filters through to different cognitive tasks. However these abilities are affected by the specific task procedures and by practice or experience of these cognitive tasks.

With regard to performance, cohort 3 showed superior ability to the younger two cohorts on all three tasks and at each of the three testing phases. Although this was probably the result of the increased age of this cohort, they were still performing consistently better across the three different tasks. Statistical comparison of these performance levels was problematic. This involved correlational assessment with low subject numbers and a narrow and disparate score range. This meant that the probability of finding a significant correlation was considerably reduced and that odd subjects performing differently to the sample as a whole, could quite dramatically distort the correlations in either direction.

It was therefore difficult to draw firm conclusions from the comparison of performance levels, however the similarity in the age differences within each task, suggests that performance levels were fairly consistent for drawing, memory and selective attention. The statistical problems encountered with the performance measures were not evident with the strategic and metacognitive abilities. All three tasks resulted in directly comparable dependent measures, i.e. three categories of strategic and metacognitive development. However this did mean that both the children's attention scores for the drawing task (seconds of time and number of looks) and their ARC clustering scores for the memory task, were converted into categorical data and therefore the sensitivity of the original scores was to some extent lost.

Both strategy use and metacognitive awareness of these strategies remained consistent across the three tasks, except where they were affected by specific task procedures. The children generally showed low levels of attentional strategy use in the drawing task. As discussed above, Cohort 3 did show high levels of looking 'within' drawing separate elements of the cup model, but only at Phase 2. Therefore on the whole the use of the extensive strategy was not particularly evident. Studies 2 and 3 (Chapters 3 and 4 respectively) showed that these strategies could be prompted in young children if they were presented with explicit instructions. However in the present study only standard instructions were given. This therefore resulted in reduced strategic ability in comparison to the memory task, where the strategy of clustering the items was prompted (grouped display type). In contrast the mixed display type provided no prompt and resulted in reduced strategic abilities compared to the selective attention task. Similarly, this latter task did not prompt the effective strategy, however increased exposure possibly led to the childs' ongoing strategic development being revealed or even accelerated. The more practice the child had of opening the windows the more they seemed to use the exhaustive strategies. Therefore the differences in strategic capabilities resulted from the specific task procedures. Strategy use was increased when the task equipped the child to cope with the task demands. When this did not occur, strategy use reduced in comparison.

Metacognitive awareness was similarly affected by the specific task procedures. Assessment of this ability, particularly with young children, is often criticised due to the possibility of strategic behaviour being subconscious, or the possibility that the children are aware of the behaviour but are unable to verbalise the basis of this (Miller & Weiss, 1981). The metacognitive questions for the drawing task required a verbal response of what was to a large extent a subtle strategy. For example, the children often attended to the model for less than one second of time in the course of producing a drawing. It was therefore not surprising that the majority of children were only able to show limited awareness of the strategy of continually attending to the drawing model. The metacognitive questions for the memory task initially involved the non-verbal response of pointing to the arrangement of cards that would aid recall. However, the children then had to make a verbal justification of their choice. The children's ability to select the correct arrangement was shown to increase across the three phases, however the young children showed no corresponding increase in awareness of why the grouped arrangement would aid recall. Norman & Henry (in press) criticised studies for using procedures that required verbal responses. They found that allowing young children to give a non-verbal response resulted in a more adequate assessment of metamemory. Awareness of both the attentional and the clustering strategies was therefore reduced in comparison to selective attention awareness. With this task, the children were able to give a non-verbal response by just pointing to the homologous matching windows. Additionally, they had increased exposure to this task and therefore by Phase 3 were showing high levels of metacognitive awareness in comparison to the drawing and memory tasks.

This research therefore demonstrates that children between the ages of four and eight show simultaneous development of performance, strategy use and metacognitive awareness, when specific task procedures are taken into account. This therefore supports the view that these different abilities are related to underlying cognitive development.

12.5 NEW THEORETICAL PERSPECTIVE

As discussed in Chapter 1 Section 4, there is a need for a new theoretical perspective which reflects the view that the children's drawing ability does not develop in distinct stages but is instead, a by-product of the attentional processes that the child allocates to the drawing task. This is evident in the way that intellectual and visual realism are artificially induced by procedural changes that manipulate attention. By increasing the amount of strategic attention that the child pays to the drawing model, intellectually realistic children can be prompted to produce visually realistic drawings. Similarly, by removing the possibility of strategically attending, visually realistic children can be prompted to produce intellectually realistic drawings.

This is therefore different to the view put forward by both Luquet and later Piaget, that drawings are a representation of the child's internal mental model, i.e. intellectual realism is viewed as the printing out of the child's canonical representation of the object in question. If this was the case an intellectually realistic child would be unaffected by procedural changes and would continue to produce stereotypical drawings under all circumstances.

This thesis does however agree with Piaget in one other respect. It is proposed that children's drawings should be understood within the context of general cognitive development. Drawings conform to the same patterns of development as memory and selective attention and therefore suggests underlying abilities common to the three different cognitive areas. Drawings do not develop in isolation and therefore they should be studied within the context with which they are established. This therefore reflects the Piagetian belief that researchers should establish a general developmental framework which integrates different areas of cognitive development.

12.6 PRACTICAL IMPLICATIONS

The practical implications for the findings of this thesis relate to the educational environment. By making instructions more explicit, by providing contrasts and manipulating attentional strategies, children's drawings can be enhanced and improved. However, this would only relate to model based drawings and it could be argued that the production of visually realistic drawings is not particularly relevant as such. However the close link between this and other cognitive abilities cannot be ignored. By teaching children strategies and exercising their metacognitive abilities, cognitive development in general could be facilitated. If there is a general underlying strategic ability, the more experience the child has at using and developing this, the more likely they are to understand strategies in general and be spontaneously strategic in other cognitive tasks.

12.7 FUTURE RESEARCH

The pattern of results presented in this thesis was generally consistent across the different studies. However there were a couple of findings that were not clarified within the present research programme.

In Study 2 (Chapter 3), the four-year-olds showed systematic performance that was quite different to the older children and to previous research. They were producing two identical drawings that were based on their view of the first model and irrespective of their view of the second. When a cup with its handle hidden from view was presented first, this young age group appeared to be producing high proportions of visually realistic drawings (omitted the hidden handle). However they then replicated this drawing for a second model of a cup with its handle visible at the side. Therefore this second drawing was neither intellectually nor visually realistic because it omitted the visible handle. It is possible that these children were just producing quick and simple drawings. However their first drawing was visually realistic, when previous research would suggest that this age group would include the hidden handle. Why they were able to draw so accurately therefore remains unanswered and further assessment of their abilities is necessary.

In Study 3, the partial occlusion model led to lower levels of visual realism in comparison to the total and non-occlusion models. However this was not generally the case with the longitudinal study. The children showed consistent drawing performance on the partial occlusion ball task and the hidden handle cup task. It is generally accepted that partial occlusions are difficult for young children to draw. The result of the present longitudinal study disagrees with this view and suggests that a partial occlusion ball model is no more difficult to draw than a cup with its handle hidden from view. However, due to a small sample size in this study it would be necessary to replicate this finding before any firm conclusions could be drawn.

There were several ways in which the longitudinal study could have been improved. The longitudinal component should ideally have been longer than one year. The initial sample size should have been greater so that the impact of the high attrition rate could have been reduced. More importantly the ages of the separate cohorts should have been more tightly controlled. In hindsight, it would have been beneficial to start the three cohorts at four years eight months, five years eight months and six years eight months. These measures would hopefully have eliminated the problems associated with the large age gap between cohorts 2 and 3, and the individual increases in development occurring between the separate cohorts.

The drawing task did not prompt the attentional strategy as only standard instructions were presented. In contrast, the memory task prompted the clustering strategy by presenting the cards in their categories. Although, not directly prompting the effective strategies, the selective attention task presented the child with multiple trials which seems to have had the same effect of increasing strategy use. Therefore, the drawing task could have been designed to be more comparable with the other two tasks by presenting both standard and explicit instructions. The cross-sectional studies had shown that explicit instructions increased strategy use. However it is still unknown whether this would also have resulted in increased metacognitive awareness of the attentional strategy.

There are therefore several findings that remain unexplained by the present series of experiments, and some ways in which the longitudinal study could have been improved. However despite these limitations, the research presented in this thesis provides consistent evidence of how drawing performance is related to strategic attention, and how this is associated with general underlying cognitive development.

12.8 CONCLUSIONS

By using an alternative methodology this thesis has established a more detailed interpretation of drawing development and the factors that have been shown to influence this. Additionally, it has shown how this ability is related to cognitive development in general. Drawing performance is closely linked to the development of strategic attention towards the drawing models. If a child is non-strategic they generally take a quick look at the model while the instructions are given, and rarely look again. This subsequently leads to the production of an intellectually realistic drawing. Children then develop the limited strategy of paying more attention to the model but again only before they start to draw. Although in some cases this can lead to the production of a visually realistic drawing, for example with a simple model, this strategy is still to a large extent associated with intellectual realism. Finally, the child develops the use of the more extensive and effective strategy of continually attending to the model while they actually draw. This generally leads to the production of a visually realistic drawing. This pattern of behaviour can be affected by prompting the child to be more strategic, for example by presenting contrasting models or explicit instructions. This therefore leads to increased performance. In contrast, reduced performance can be produced by removing the possibility of using the more extensive strategies. This developmental pattern is similar to those observed in memory and selective attention, and the evidence supports the view that there is a general cognitive strategic ability underlying this development, which underpins performance on different cognitive tasks.

LIST OF APPENDICES

APPENDIX A

SCHEFFE'S METHOD OF FOLLOW-UP ANALYSIS

This method was used due to its ability to assess significant differences between any number of means, and particularly where there are within subject factors. It is also a very stringent method of follow-up analysis and therefore reduces the incidence of Type I errors.

The formula used was as follows:-

$$\text{Scheffe F} = \left(\frac{\text{Mean 1 - Mean 2}}{\sqrt{\text{MSerror} \quad (1/\text{N1} + 1/\text{N2})}} \right)^2$$

This is then compared to the F table value:-

F (factor d.f. , error d.f.) x (total number of means - 1).

Therefore although the Scheffe F values appear high in the text, this has to be compared to an F significance value that is multiplied by the total number of means being assessed minus one.

Scheffe's follow-up analysis therefore holds the significance level constant across the total number of comparisons made.

APPENDIX B

Summary ANOVA tables and details of subsidiary findings for Study 1 (Chapter 2).

TABLE B.1 **SUMMARY ANOVA TABLE FOR TOTAL NUMBER OF LOOKS BY DRAWING ORDER**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	86.892	72	1.207			
Age	73.662	2	36.831	30.519	<0.001	
Error	35.369	288	0.123			
Drawing Order	4.061	4	1.015	8.266	**<0.001**	**<0.001**
Drawing Order*Age	2.303	8	0.288	2.344	**<0.05**	**<0.05**

† Epsilon corrected (Greenhouse-Geiser) probability values.
The main findings are highlighted.

TABLE B.2 **SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	65.163	72	0.905			
Age	63.037	2	31.518	34.825	**<0.001**	
Error	35.144	288	0.122			
Task	2.780	4	0.695	5.696	**<0.001**	**<0.001**
Task*Age	3.204	8	0.401	3.282	**<0.001**	**<0.01**
Error	131.753	216	0.610			
Look Type	174.578	3	58.193	95.403	**<0.001**	**<0.001**
Look Type*Age	79.014	6	13.169	21.590	**<0.001**	**<0.001**
Error	108.890	864	0.126			
Look Type*Task	8.141	12	0.678	5.383	**<0.001**	**<0.001**
Look Type*Task*Age	9.531	24	0.397	3.151	**<0.001**	**<0.001**

† Epsilon corrected (Greenhouse-Geiser) probability values.
The main findings are highlighted.

TABLE B.3 **SUMMARY ANOVA TABLES FOR NUMBER OF LOOKS BY DRAWING REALISM**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	2.852	40	0.071			
Age	0.446	1	0.446	6.261	<0.05	
Task 1 Realism (T1)	0.012	1	0.012	0.171	**n.s.**	
Age*Realism	0.012	1	0.012	0.171	n.s.	
Error	9.840	120	0.082			
Look Type (L.T.)	25.298	3	8.433	102.834	<0.001	<0.001
Look Type*Age	0.263	3	0.088	1.070	n.s.	n.s.
Look Type*Realism	0.067	3	0.022	0.273	n.s.	n.s.
L.T.*Realism(T1)*Age	0.067	3	0.022	0.273	**n.s.**	**n.s.**
Error	25.042	52	0.482			
Age	0.217	2	0.108	0.225	n.s.	
Task 2 Realism (T2)	0.454	1	0.454	0.942	**n.s.**	
Age*Realism	1.659	2	0.830	1.723	n.s.	
Error	48.424	156	0.310			
Look Type (L.T.)	8.549	3	2.850	9.181	<0.001	<0.001
Look Type*Age	0.806	6	0.134	0.433	n.s.	n.s.
Look Type*Realism	0.340	3	0.113	0.366	n.s.	n.s.
L.T.*Realism(T2)*Age	1.291	6	0.215	0.693	**n.s.**	**n.s.**
Error	11.145	63	0.177			
Age	2.259	2	1.129	6.384	<0.01	
Task 3 Realism (T3)	0.598	1	0.598	3.382	**n.s.**	
Age*Realism	0.275	2	0.137	0.777	n.s.	
Error	47.302	189	0.250			
Look Type (L.T.)	18.188	3	6.063	24.225	<0.001	<0.001
Look Type*Age	3.310	6	0.552	2.205	<0.05	n.s.
Look Type*Realism	0.524	3	0.175	0.698	n.s.	n.s.
L.T.*Realism(T3)*Age	0.692	6	0.115	0.461	**n.s.**	**n.s.**
Error	21.802	48	0.454			
Age	3.951	2	1.976	4.350	<0.05	
Task 4 Realism (T4)	0.154	1	0.154	0.340	**n.s.**	
Age*Realism	0.759	2	0.379	0.835	n.s.	
Error	41.371	144	0.387			
Look Type (L.T.)	10.184	3	3.395	11.816	<0.001	<0.001
Look Type*Age	3.561	6	0.594	2.066	n.s.	n.s.
Look Type*Realism	0.117	3	0.039	0.136	n.s.	n.s.
L.T.*Realism(T4)*Age	1.271	6	0.212	0.737	**n.s.**	**n.s.**
Error	12.011	43	0.279			
Age	2.579	2	1.290	4.617	<0.05	
Task 5 Realism (T5)	1.374	1	1.374	4.917	**<0.05**	
Age*Realism	1.458	2	0.729	2.609	n.s.	
Error	33.759	129	0.262			
Look Type (L.T.)	10.180	3	3.393	12.967	<0.001	<0.001
Look Type*Age	3.758	6	0.626	2.393	<0.05	n.s.
Look Type*Realism	1.190	3	0.397	1.516	n.s.	n.s.
L.T.*Realism(T5)*Age	5.926	6	0.988	3.774	**<0.01**	**<0.05**

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

Tasks 1, 3, 4 and 5 showed significant main effects of age (ps<.05). For Tasks 1, 3 and 4, the four-year-olds looked at the models less than the six- and eight-year-olds (Scheffe ps<.05), with the latter two age groups not being significantly different from each other. For Task 5, the six-year-olds looked significantly less than the eight-year-olds (Scheffe p<.001), with the four-year-olds showing no significant difference to the eight-year-olds. All tasks showed a significant main effect of look type (ps<.001). Scheffe follow-up analysis showed that the 'beginning' looks were significantly greater than all other look types, for Tasks 1, 2, 3 and 4. Additionally, for Task 3 the 'within' looks were greater than the 'end' looks, and for Tasks 2 and 4 both the 'within' and 'between' looks were greater than the 'end' looks (ps<.05). For Task 5 both the 'within' and 'between' looking proved to be similar to the 'beginning' looks, therefore resulting in only the 'end' looks being significantly lower than all other look types (Scheffe ps<.001).

TABLE B.4 **SUMMARY ANOVA TABLE FOR TOTAL LOOKING TIME BY DRAWING ORDER**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	4.747	72	0.066			
Age	1.968	2	0.984	14.929	<0.001	
Error	6.912	288	0.024			
Drawing Order	1.355	4	0.339	14.117	**<0.001**	**<0.001**
Drawing Order*Age	0.342	8	0.043	1.779	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

There was a main effect of age (F(2,72)=14.93 p<.001) in that the four-year-olds looked less than the six-year-olds, who in turn looked less than the eight-year-olds (ps<.05).

TABLE B.5 **SUMMARY ANOVA TABLE FOR LOOKING TIME**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	10.040	72	0.139			
Age	6.993	2	3.496	25.075	**<0.001**	
Error	7.294	288	0.025			
Task	1.116	4	0.279	11.021	**<0.001**	**<0.001**
Task*Age	0.526	8	0.066	2.597	**<0.01**	**<0.05**
Error	17.587	216	0.081			
Look Type	73.426	3	24.475	300.597	**<0.001**	**<0.001**
Look Type*Age	9.494	6	1.582	19.434	**<0.001**	**<0.001**
Error	20.690	864	0.024			
Look Type*Task	1.796	12	0.150	6.252	**<0.001**	**<0.001**
Look Type*Task*Age	1.320	24	0.055	2.296	**<0.001**	**<0.01**

† Epsilon corrected (Greenhouse-Geiser) probability values.
The main findings are highlighted.

TABLE B.6 **SUMMARY ANOVA TABLES FOR LOOKING TIME BY DRAWING REALISM**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	0.684	40	0.017			
Age	0.024	1	0.024	1.425	n.s.	
Task 1 Realism (T1)	0.032	1	0.032	1.869	n.s.	
Age*Realism	0.011	1	0.011	0.624	n.s.	
Error	1.285	120	0.011			
Look Type (L.T.)	7.370	3	2.457	229.403	<0.001	<0.001
Look Type*Age	0.059	3	0.020	1.837	n.s.	n.s.
Look Type*Realism	0.107	3	0.036	3.327	**<0.05**	**<0.05**
L.T.*Realism(T1)*Age	0.039	3	0.013	1.226	**n.s.**	**n.s.**
Error	3.630	52	0.070			
Age	0.027	2	0.014	0.194	n.s.	
Task 2 Realism (T2)	0.078	1	0.078	1.120	**n.s.**	
Age*Realism	0.300	2	0.150	2.150	n.s.	
Error	7.046	156	0.045			
Look Type (L.T.)	3.194	3	1.065	23.573	<0.001	<0.001
Look Type*Age	0.325	6	0.054	1.198	n.s.	n.s.
Look Type*Realism	0.054	3	0.018	0.396	n.s.	n.s.
L.T.*Realism(T2)*Age	0.231	6	0.038	0.852	**n.s.**	**n.s.**
Error	2.332	63	0.037			
Age	0.358	2	0.179	4.831	<0.05	
Task 3 Realism (T3)	0.135	1	0.135	3.656	**n.s.**	
Age*Realism	0.176	2	0.088	2.371	n.s.	
Error	8.297	189	0.044			
Look Type (L.T.)	8.049	3	2.683	61.118	<0.001	<0.001
Look Type*Age	0.639	6	0.107	2.427	<0.05	<0.05
Look Type*Realism	0.023	3	0.008	0.174	n.s.	n.s.
L.T.*Realism(T3)*Age	0.181	6	0.030	0.689	**n.s.**	**n.s.**
Error	4.551	48	0.095			
Age	0.198	2	0.099	1.042	n.s.	
Task 4 Realism (T4)	0.032	1	0.032	0.334	**n.s.**	
Age*Realism	0.038	2	0.019	0.203	n.s.	
Error	7.293	144	0.051			
Look Type (L.T.)	6.350	3	2.117	41.795	<0.001	<0.001
Look Type*Age	0.848	6	0.141	2.789	<0.05	<0.05
Look Type*Realism	0.063	3	0.021	0.417	n.s.	n.s.
L.T.*Realism(T4)*Age	0.270	6	0.045	0.889	**n.s.**	**n.s.**
Error	2.093	43	0.049			
Age	0.252	2	0.126	2.587	n.s.	
Task 5 Realism (T5)	0.079	1	0.079	1.617	**n.s.**	
Age*Realism	0.256	2	0.128	2.630	n.s.	
Error	4.311	129	0.033			
Look Type (L.T.)	3.925	3	1.308	39.149	<0.001	<0.001
Look Type*Age	0.451	6	0.075	2.249	<0.05	n.s.
Look Type*Realism	0.253	3	0.084	2.518	n.s.	n.s.
L.T.*Realism(T5)*Age	0.531	6	0.089	2.649	**<0.05**	**<0.05**

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

Task 3 showed a significant main effect of age ($F(2,63)=4.83$ $p<.05$), in that the four-year-olds looked at the models less than the eight-year-olds (Scheffe $F(2,63)=14.58$ $p<.01$). All five tasks showed a significant main effect of look type ($ps<.001$) where the 'beginning' looks were significantly greater than all other look types. Additionally for Tasks 2, 3 and 5 the 'within' and 'between' looks were greater than the 'end' looks, and for Task 4 just the 'between' looks were greater than the 'end' looks (Scheffe $ps<.05$). Tasks 3 and 4 also showed an interaction between age and look type (Scheffe $ps<.05$) which revealed that the eight-year-olds showed high levels of 'within' looking.

APPENDIX C

LOG-LINEAR MODELLING

The assessment of children's drawings often involves categorical data, for example whether a child produces an intellectually or a visually realistic drawing. Analysis of this data involves assessment of how the proportion of these two categories of children vary in relation to independent variables, for example different instructional conditions. The Chi-Square test usually employed for this purpose only allows assessment of one independent variable at any one time, irrespective of the total number of variables in the experiment. Therefore interactions between variables cannot be assessed. This test calculates the expected cell frequencies (under the assumption that the variables are independent) which are then compared to the observed frequencies. A large discrepancy between these frequencies results in a significant chi-square statistic and the subsequent rejection of the null hypothesis of independence. Therefore interpretation of the analysis leads to the conclusion that the independent variable has produced a significant effect on the dependent variable.

Log-Linear Modelling (LLM) adopts these basic principles but allows for the assessment of interactions between several variables. It does this by generating expected frequencies based on several models, which includes a model of independence and models based on the several possible main effects and interactions between the different variables. Like the chi-square test the LLM does not distinguish between independent and dependent variables, the distinction between them is made when interpreting the analysis. Each possible model is then compared to the observed frequencies in a hierarchical fashion. The model that provides the best 'fit' between the observed and expected frequencies is subsequently adopted.

LLM can only be employed if at least 80% of the expected cell frequencies of the full model incorporating all variables, are greater than five. If this is not the case, variables can be collapsed and several LLM analyses performed. Although this is not ideal, this procedure is still preferable the calculating many more chi-square tests.

PROCEDURE

Firstly the complete interaction model or 'saturated model' is considered. This contains all the variables included in the analysis, for example the saturated model for the factors instruction, exposure and the dependent variable of drawing realism, would be the three way interaction between them. In this case the expected frequencies are forced to be exactly equal to the observed frequencies.

The likelihood ratio for chi-square *change* is then computed. This is a measure of how the overall chi-square statistic for the model would change if this interaction was removed from the model. A significant change would mean that this interaction *is* necessary to explain the observed data, and therefore the saturated model is accepted. If this change is non-significant the interaction *is not* necessary and lower order models are then assessed. In the example detailed above the next model would contain the three possible two-way interactions. The likelihood ratio chi-square for the whole model and the likelihood ratios for chi-square change for each of the three simple effects are calculated. Non-significant effects are then removed one at a time i.e. the effect with the lowest chi-square statistic. The next lower order model is then assessed in the same way. This proecedure is repeated until only those simple effects (interactions and/or main effects) that would lead to a significant change in the chi-square statistic for the overall model remain.

A way of testing how well the model fits the observed data is to examine the residuals (i.e. the difference between the observed frequencies and the expected frequencies based on the selected model) and the standardised residuals (residuals / square-root of the expected frequencies). If the selected model fits the observed data adequately, these residuals should be fairly small. If the standardised residuals are greater than 1.96, or less than -1.96 this would suggest that the final model does not provide an adequate fit or explanation of the observed frequencies.

For further information about the LLM procedure see Kennedy (1981) and Howell (1992).

FOLLOW-UP PROCEDURE

For dichotomous variables the follow-up procedure described by Kennedy (1981 pages 103 and 149) was employed. This involves calculating lambda values for each observed frequency in the selected model. Examination of the algebraic signs of these values illustrates the direction of the frequency in question. In the example shown below (this is actually Table 3.7 from the main text) the positive lambda values would indicate that there were more visually realistic drawings with the HN task order and more intellectually realistic drawings with the NH order. In order to establish the significance of the lambda values, Z scores are calculated. Z scores greater than +1.96 or less than -1.96 significantly deviate from zero. In the example all effects are significant and therefore this leads to the conclusion of a significant pattern of results.

	VISUAL REALISM			INTELLECTUAL REALISM		
Task Order	Observed Frequency	Lambda	Z Tests*	Observed Frequency	Lambda	Z Tests*
HN	35	+0.22	+2.11	15	-0.22	-2.11
NH	25	-0.22	-2.11	26	+0.22	+2.11
TOTAL	60	0.00	0.00	41	0.00	0.00

Where the variables are polytomous the follow-up analysis used by Lewis, Russell & Berridge (1992) was employed. This involved calculating separate chi-square tests for each possible 2 x 2 cross-classification table, with a correction procedure to the probability value equivalent to the total number of chi-square tests calculated. This procedure was only relevant for Study 3 (Chapter 4) and is described in more detail in Section 4.3.1.

APPENDIX D

The following tables detail the Log-Linear model selection precedure for the drawing data for Study 2 (Chapter 3). The Likelihood Ratios for Chi-Square Change show how the chi-square statistic for the overall model would change if that particular simple effect was removed from the model. Therefore in a series of steps, the non-significant simple effect with the lowest Likelihood Ratio is removed and the model is recomputed. The final model selected therefore includes only those effects that would make a significant reduction to the statistic if removed.

When an appropriate model is selected the residuals (i.e. the difference between the observed frequencies and the expected frequencies based on the selected model) and the standardised residuals (residuals / square-root of the expected frequencies) are calculated. If the selected model fits the observed data adequately, these residuals should be fairly small. If the standardised residuals are greater than 1.96, or less than -1.96 this would suggest that the final model does not provide an adequate fit or explanation of the observed frequences.

FOUR-YEAR-OLD DRAWING DATA

TABLE D.1 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING EXPOSURE, ORDER AND DRAWING REALISM (HANDLE HIDDEN TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Exposure*Order*Realism	3.286	1	n.s.
2	Exposure*Order,	0.288	1	n.s.
	Exposure*Realism,	0.952	1	n.s.
	Order*Realism	1.085	1	n.s.
3	Exposure*Realism,	1.112	1	n.s.
	Order*Realism	1.245	1	n.s.
4	Order*Realism,	1.245	1	n.s.
	Exposure	0.711	1	n.s.
5	Order*Realism	1.245	1	n.s.
6	Order,	0.363	1	n.s.
	Realism	0.130	1	n.s.
7	Order	0.363	1	n.s.

* Change in Chi-square statistic if the simple effect is deleted.

† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.

TABLE D.2 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING INSTRUCTION, ORDER AND DRAWING REALISM (HANDLE HIDDEN TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Instruction*Order*Realism	3.066	1	n.s.
2	Instruction*Order, **Instruction*Realism,** Order*Realism	2.026 10.757 2.475	1 1 1	n.s. **<0.01** n.s.
3	**Instruction*Realism,** Order*Realism	9.527 1.245	1 1	**<0.01** n.s.
4	**Instruction*Realism,** Order	9.527 0.363	1 1	**<0.01** n.s.
5	**Instruction*Realism**	9.527	1	**<0.01**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE D.3 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING INSTRUCTION, EXPOSURE AND DRAWING REALISM (HANDLE HIDDEN TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Instruction*Expsoure*Realism	0.437	1	n.s.
2	Instruction*Exposure, **Instruction*Realism,** Exposure*Realism	0.093 9.173 0.758	1 1 1	n.s. **<0.01** n.s.
3	**Instruction*Realism,** Exposure*Realism	9.527 1.112	1 1	**<0.01** n.s.
4	**Instruction*Realism,** Exposure	9.527 0.711	1 1	**<0.01** n.s.
5	**Instruction*Realism**	9.527	1	**<0.01**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE D.4 OBSERVED, EXPECTED FREQUENCIES AND RESIDUALS BASED ON THE SELECTED MODEL OF INSTRUCTION * DRAWING REALISM

Instr-uctions	Order/ Realism †	Observed Frequency	Expected Frequency	Residuals	Standardised Residuals
Standard	HN VR	9.00	12.00	-3.000	-0.866
	HN IR	10.00	6.50	+3.500	+1.373
	NH VR	15.00	12.00	+3.000	+0.866
	NH IR	3.00	6.50	-3.500	-1.373
Explicit	HN VR	4.00	4.50	-0.500	-0.236
	HN IR	9.00	11.50	-2.500	-0.737
	NH VR	5.00	4.50	+0.500	+0.236
	NH IR	14.00	11.50	+2.500	+0.737

† HN = Handle/No Handle NH = No Handle/Handle.
VR = Visual Realism IR = Intellectual Realism.

TABLE D.5 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING INSTRUCTION, ORDER AND DRAWING REALISM (HANDLE VISIBLE TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Instruction*Order*Realism	1.186	1	n.s.
2	Instruction*Order,	1.926	1	n.s.
	Instruction*Realism,	4.580	1	**<0.05**
	Order*Realism	2.879	1	n.s.
3	**Instruction*Realism,**	3.661	1	**=0.05**
	Order*Realism	1.960	1	n.s.
4	**Instruction*Realism,**	3.661	1	**=0.05**
	Order	0.235	1	n.s.
5	**Instruction*Realism**	3.661	1	**=0.05**
6	Instruction,	0.235	1	n.s.
	Realism	4.822	1	**<0.05**
7	**Realism**	4.822		**<0.05**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE D.6 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING INSTRUCTION, EXPOSURE AND DRAWING REALISM (HANDLE VISIBLE TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Instruction*Expsoure*Realism	0.044	1	n.s.
2	Instruction*Exposure, **Instruction*Realism,** Exposure*Realism	0.199 3.561 0.141	1 1 1	n.s. **=0.05** n.s.
3	**Instruction*Realism,** Exposure*Realism	3.661 0.299	1 1	**=0.05** n.s.
4	**Instruction*Realism,** Exposure	3.661 0.943	1 1	**=0.05** n.s.
5	**Instruction*Realism**	3.661	1	**=0.05**
6	Instruction, Realism	0.235 4.822	1 1	n.s. **<0.05**
7	**Realism**	4.822	1	**<0.05**

* Change in Chi-square statistic if the simple effect is deleted.

† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.

The significant effects are highlighted.

TABLE D.7 OBSERVED, EXPECTED FREQUENCIES AND RESIDUALS BASED ON THE SELECTED MODEL OF DRAWING REALISM

Instr-uctions	Order/ Realism †	Observed Frequency	Expected Frequency	Residuals	Standardised Residuals
Standard	HN VR	13.00	10.75	+2.250	+0.686
	HN IR	6.00	6.25	-0.250	-0.100
	NH VR	6.00	10.75	-4.750	-1.449
	NH IR	11.00	6.25	+4.750	+1.900
Explicit	HN VR	10.00	10.75	-0.750	-0.229
	HN IR	3.00	6.25	-3.250	-1.300
	NH VR	14.00	10.75	+3.250	+0.991
	NH IR	5.00	6.25	-1.250	-0.500

† HN = Handle/No Handle NH = No Handle/Handle.
VR = Visual Realism IR = Intellectual Realism.

TABLE D.8 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING EXPOSURE, ORDER AND DRAWING REALISM (HANDLE VISIBLE TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	**Exposure*Order*Realism**	4.441	1	**<0.05**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effect is highlighted.

Note: Due to the selection of the saturated model, the expected frequencies were equal to the observed frequencies, and therefore the residuals and standardised residuals were zero.

SIX-YEAR-OLD DRAWING DATA

TABLE D.9 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING INSTRUCTION, EXPOSURE, ORDER AND DRAWING REALISM (HIDDEN HANDLE TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Instruction*Expsoure*Order*Realism	0.635	1	n.s.
2	Instruction*Exposure*Order, **Instruction*Exposure*Realism,** Instruction*Order*Realism, Exposure*Order*Realism	0.011 4.860 0.842 0.000	1 1 1 1	n.s. **<0.05** n.s. n.s.
3	Instruction*Exposure*Order **Instruction*Exposure*Realism,** Instruction*Order*Realism	0.013 4.862 0.870	1 1 1	n.s. **<0.05** n.s.
4	**Instruction*Exposure*Realism,** Instruction*Order*Realism, Exposure*Order	5.013 1.011 0.050	1 1 1	**<0.05** n.s. n.s.
5	**Instruction*Exposure*Realism,** Instruction*Order*Realism	5.173 1.170	1 1	**<0.01** n.s.
6	**Instruction*Exposure*Realism,** Instruction*Order Order*Realism	5.173 0.064 4.706	1 1 1	**<0.05** n.s. **<0.05**
7	**Instruction*Expousre*Realism,** **Order*Realism**	5.173 4.652	1 1	**<0.05** **<0.05**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE D.10 OBSERVED, EXPECTED FREQUENCIES AND RESIDUALS BASED ON THE SELECTED MODEL OF ORDER * DRAWING REALISM AND INSTRUCTIONS * EXPOSURE * DRAWING REALISM

Instructions/ Exposure	Order/ Realism †	Observed Frequency	Expected Frequency	Residuals	Standardised Residuals
Standard Continuous	HN VR	10.00	8.75	+1.250	+0.423
	HN IR	3.00	4.02	-1.024	-0.511
	NH VR	5.00	6.25	-1.250	-0.500
	NH IR	8.00	6.98	+1.024	+0.388
Standard Short	HN VR	8.00	7.58	+0.417	+0.151
	HN IR	4.00	4.02	-0.024	-0.012
	NH VR	5.00	5.42	-0.417	-0.179
	NH IR	7.00	6.98	+0.024	+0.009
Explicit Continuous	HN VR	11.00	12.83	-1.833	-0.512
	HN IR	2.00	1.46	-0.537	+0.444
	NH VR	11.00	9.17	+1.883	+0.606
	NH IR	2.00	2.54	-0.537	-0.337
Explicit Short	HN VR	6.00	5.83	+0.167	+0.069
	HN IR	6.00	5.49	+0.512	+0.219
	NH VR	4.00	4.17	-0.167	-0.082
	NH IR	9.00	9.51	-0.512	-0.166

† HN = Handle/No Handle NH = No Handle/Handle.
VR = Visual Realism IR = Intellectual Realism.

EIGHT-YEAR-OLD DRAWING DATA

TABLE D.11 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING EXPOSURE, ORDER AND DRAWING REALISM (HANDLE HIDDEN TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Exposure*Order*Realism	0.393	1	n.s.
2	Exposure*Order,	0.393	1	n.s.
	Exposure*Realism,	4.324	1	**<0.05**
	Order*Realism	11.649	1	**<0.001**
3	**Exposure*Realism,**	3.931	1	**<0.05**
	Order*Realism	11.256	1	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE D.12 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING INSTRUCTION, EXPOSURE AND DRAWING REALISM (HANDLE HIDDEN TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Instruction*Expsoure*Realism	0.273	1	n.s.
2	Instruction*Exposure, Instruction*Realism, **Exposure*Realism**	0.040 1.240 3.971	1 1 1	n.s. n.s. **<0.05**
3	Instruction*Realism, **Exposure*Realism**	1.200 3.931	1 1	n.s. **<0.05**
4	**Exposure*Realism,** Instructions	3.931 0.000	1 1	**<0.05** n.s.
5	**Exposure*Realism**	3.931	1	**<0.05**

* Change in Chi-square statistic if the simple effect is deleted.

† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.

The significant effects are highlighted.

TABLE D.13 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING INSTRUCTION, ORDER AND DRAWING REALISM (HANDLE HIDDEN TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Instruction*Order*Realism	0.096	1	n.s.
2	Instruction*Order, Instruction*Realism, **Order*Realism**	0.119 1.319 11.374	1 1 1	n.s. n.s. **<0.001**
3	Instruction*Realism, **Order*Realism**	1.200 11.256	1 1	n.s. **<0.001**
4	**Order*Realism,** Instructions	11.256 0.000	1 1	**<0.001** n.s.
5	**Order*Realism**	11.256	1	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.

† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.

The significant effects are highlighted.

TABLE D.14 OBSERVED, EXPECTED FREQUENCIES AND RESIDUALS BASED ON THE SELECTED MODEL OF EXPOSURE * DRAWING REALISM AND ORDER * DRAWING REALISM

Exposure	Order/ Realism †	Observed Frequency	Expected Frequency	Residuals	Standardised Residuals
Continuous	HN VR	29.00	29.61	-0.613	-0.113
	HN IR	1.00	2.00	-1.000	-0.707
	NH VR	22.00	21.39	+0.613	+0.133
	NH IR	8.00	7.00	+1.000	+0.378
Short	HN VR	25.00	24.39	+0.613	+0.124
	HN IR	5.00	4.00	+1.000	+0.500
	NH VR	17.00	17.61	-0.613	-0.146
	NH IR	13.00	14.00	+1.000	-0.267

† HN = Handle/No Handle NH = No Handle/Handle.
VR = Visual Realism IR = Intellectual Realism.

APPENDIX E

Summary ANOVA tables and details of subsidiary findings for Study 2 (Chapter 3).

TABLE E.1 **SUMMARY ANOVA TABLE FOR TOTAL NUMBER OF LOOKS (CONTINUOUS AND SHORT EXPOSURES)**

SOURCE	S.S.	D.F.	M.S.	F.	P.
Error	23.129	274	0.084		
Age	0.024	2	0.012	0.145	**n.s.**
Instructions (Inst.)	0.004	1	0.004	0.052	**n.s.**
Exposure (Exp.)	7.044	1	7.044	83.451	**<0.001**
Task Order (T.O.)	0.097	1	0.097	1.145	n.s.
Age*Instructions	0.122	2	0.061	0.723	n.s.
Age*Exposure	3.165	2	1.583	18.750	**<0.001**
Age*Task Order	0.018	2	0.009	0.106	n.s
Instructions*Exposure	0.956	1	0.956	11.324	**<0.001**
Instructions*Task Order	0.004	1	0.004	0.046	n.s.
Exposure*Task Order	0.000	1	0.000	0.004	n.s.
Age*Instructions*Exposure	0.072	2	0.036	0.424	n.s.
Age*Instructions*Task Order	0.057	2	0.029	0.340	n.s.
Age*Exposure*Task Order	0.037	2	0.018	0.216	n.s.
Inst.*Exposure*Task Order	0.299	1	0.299	3.544	n.s.
Age*Inst.*Exp.*Task Order	0.002	2	0.001	0.012	n.s.
Error	11.768	274	0.043		
Drawing Order (D.O.)	4.127	1	4.127	96.083	**<0.001**
Age*Drawing Order	0.055	2	0.027	0.634	n.s.
Instructions*Drawing Order	0.019	1	0.019	0.441	n.s.
Exposure*Drawing Order	0.027	1	0.027	0.622	n.s.
Task Order*Drawing Order	0.003	1	0.003	0.078	n.s.
Age*Inst.*Drawing Order	0.036	2	0.018	0.415	n.s.
Age*Exposure*D.O.	0.133	2	0.067	1.549	n.s.
Age*Task Order*D.O.	0.110	2	0.055	1.281	n.s.
Instructions*Exposure*D.O.	0.019	1	0.019	0.448	n.s.
Instructions*Task Order*D.O.	0.010	1	0.010	0.226	n.s.
Exposure*Task Order*D.O.	0.014	1	0.014	0.315	n.s.
Age*Instructions*Exp.*D.O.	0.011	2	0.005	0.128	n.s.
Age*Instructions*T.O.*D.O.	0.200	2	0.100	2.334	n.s.
Age*Exposure*Task Order*D.O.	0.019	2	0.010	0.222	n.s.
Instructions*Exp.*T.O.*D.O.	0.040	1	0.040	0.933	n.s.
Age*Inst.*Exposure*T.O.*D.O.	0.026	2	0.013	0.304	n.s.

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The significant interaction between instructions and exposure durations ($F(1,274)=11.32$ $p<.001$) revealed that although both the standard and the explicit instructions showed the continuous exposure leading to greater levels of looking, the effect was at a higher level of significance with the explicit instructions (Scheffe $F(1,274)=17.07$ $p<.05$ and 80.49 $p<.001$ respectively). See Table E.2 for details of the means.

TABLE E.2 MEAN NUMBER OF LOOKS PER INSTRUCTION AND EXPOSURE

INSTRUCTION	N	CONTINUOUS	SHORT	MEAN TOTAL*
STANDARD	147	0.45 (3.44)	0.59 (1.95)	**0.52 (2.70)**
EXPLICIT	151	0.38 (4.35)	0.68 (1.79)	**0.53 (3.07)**
MEAN TOTAL*		**0.42 (3.90)**	**0.63 (1.87)**	

*Note: Due to reciprocal transformation the short exposure shows the lowest mean. Untransformed means (number of looks) are shown in parentheses.

TABLE E.3 HIDDEN HANDLE TASK - SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS BY REALISM REALISM (CONTINUOUS AND SHORT EXPOSURES)

SOURCE	S.S.	D.F.	M.S.	F.	P.
Error	15.724	262	0.060		
Age	0.215	2	0.107	1.787	n.s.
Instructions	0.004	1	0.004	0.059	n.s.
Exposure	2.321	1	2.321	38.668	<0.001
Drawing Realism	0.035	1	0.035	0.583	**n.s.**
Age*Instructions	0.070	2	0.035	0.580	n.s.
Age*Exposure	0.304	2	0.152	2.530	n.s.
Age*Realism	0.048	2	0.024	0.402	n.s.
Instructions*Exposure	0.179	1	0.179	2.976	n.s.
Instructions*Realism	0.001	1	0.001	0.024	n.s.
Exposure*Realism	0.132	1	0.132	2.200	n.s.
Age*Instructions*Exposure	0.034	2	0.017	0.285	n.s.
Age*Instructions*Realism	0.058	2	0.029	0.482	n.s.
Age*Exposure*Realism	0.301	2	0.150	2.505	n.s.
Instructions*Exposure*Realism	0.003	1	0.003	0.043	n.s.
Age*Instructions*Exposure *Realism	0.105	2	0.053	0.876	n.s.

n.s = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

There was a main effect of exposure (F(1,262)=38.67 p<.001) where the continuous exposure led to greater looking than the short exposure (mean number of looks = 3.43 and 1.91 respectively).

TABLE E.4 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS (CONTINUOUS EXPOSURE)

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	8.813	137	0.064			
Age	2.250	2	1.125	17.490	**<0.001**	
Instructions (Inst.)	0.287	1	0.287	4.468	**<0.05**	
Task Order (T.O.)	0.017	1	0.017	0.259	n.s.	
Age*Instructions	0.215	2	0.107	1.670	n.s.	
Age*Task Order	0.056	2	0.028	0.437	n.s.	
Inst.*Task Order	0.082	1	0.082	1.275	n.s.	
Age*Inst.*Task Order	0.011	2	0.005	0.084	n.s.	
Error	2.133	137	0.016			
Drawing Order (D.O.)	0.791	1	0.791	50.814	**<0.001**	
Age*Drawing Order	0.103	2	0.051	3.305	<0.05	
Instructions*D.O.	0.035	1	0.035	2.236	n.s.	
Task Order*D.O.	0.110	1	0.110	7.076	<0.01	
Age*Inst.ructions*D.O.	0.004	2	0.002	0.130	n.s.	
Age*Task Order*D.O.	0.159	2	0.080	5.122	<0.01	
Instructions*T.O.*D.O.	0.006	1	0.006	0.392	n.s.	
Age*Inst.*T.O.*D.O.	0.030	2	0.015	0.947	n.s.	
Error	17.857	411	0.043			
Look Type (L.T.)	31.633	3	10.544	242.698	**<0.001**	**<0.001**
Age*Look Type	2.613	6	0.435	10.023	**<0.001**	**<0.001**
Inst.*Look Type	0.517	3	0.172	3.968	<0.01	<0.05
Task Order*Look Type	0.071	3	0.024	0.542	n.s.	n.s.
Age*Inst.*Look Type	0.623	6	0.104	2.389	**<0.05**	**<0.05**
Age*T.O.*Look Type	0.388	6	0.065	1.487	n.s.	n.s.
Inst.*T.O.*Look Type	0.062	3	0.021	0.475	n.s.	n.s.
Age*Inst.*T.O.*L.T.	0.103	6	0.017	0.396	n.s.	n.s.
Error	7.860	411	0.019			
D.O.*Look Type	0.624	3	0.208	10.875	<0.001	<0.001
Age*D.O.*Look Type	0.189	6	0.031	1.647	n.s.	n.s.
Inst.*D.O.*Look Type	0.012	3	0.004	0.216	n.s.	n.s.
Task Order*D.O.*L.T.	0.770	3	0.257	13.415	<0.001	<0.001
Age*Inst.*D.O.*L.T.	0.061	6	0.010	0.535	n.s.	n.s.
Age*T.O.*D.O.*L.T.	0.462	6	0.077	4.023	**<0.01**	**<0.01**
Inst.*T.O.*D.O.*L.T.	0.006	3	0.002	0.102	n.s.	n.s.
Age*Inst.*Task Order* D.O.*Look Type	0.161	6	0.027	1.404	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

TABLE E.5 **HIDDEN HANDLE TASK - SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS BY DRAWING REALISM (CONTINUOUS EXPOSURE)**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	4.644	126	0.037			
Age	0.084	2	0.042	1.135	n.s.	
Instructions (Inst.)	0.066	1	0.066	1.799	n.s.	
Drawing Realism	0.129	1	0.129	3.492	**0.064**	
Age*Instructions	0.012	2	0.006	0.162	n.s.	
Age*Realism	0.094	2	0.047	1.278	n.s.	
Instructions*Realism	0.000	1	0.000	0.013	n.s.	
Age*Inst.*Realism	0.048	2	0.024	0.648	n.s.	
Error	11.658	378	0.031			
Look Type (L.T.)	10.814	3	3.605	116.875	<0.001	<0.001
Age*Look Type	0.319	6	0.053	1.723	n.s.	n.s.
Inst.*Look Type	0.166	3	0.055	1.790	n.s.	n.s.
Realism*Look Type	0.331	3	0.110	3.577	**<0.05**	**<0.05**
Age*Instructions*L.T.	0.146	6	0.024	0.789	n.s.	n.s.
Age*Realism*L.T.	0.300	6	0.050	1.622	**n.s.**	**n.s.**
Inst.*Realism*L.T.	0.056	3	0.019	0.601	n.s.	n.s.
Age*Inst.*Realism*L.T.	0.070	6	0.012	0.378	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The ANOVA also showed a main effect of look type (F(2,250)=116.87 p<.001*) where each of the four look types were significantly different from the other three (Scheffe ps<.05).

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE E.6 **SUMMARY ANOVA TABLE FOR TOTAL LOOKING TIME (CONTINUOUS AND SHORT EXPOSURES)**

SOURCE	S.S.	D.F.	M.S.	F.	P.
Error	11.733	274	0.043		
Age	2.552	2	1.276	29.800	**<0.001**
Instructions (Inst.)	0.981	1	0.981	22.901	**<0.001**
Exposure (Exp.)	0.003	1	0.003	0.073	**n.s.**
Task Order (T.O.)	0.016	1	0.016	0.371	n.s.
Age*Instructions	0.055	2	0.027	0.641	n.s.
Age*Exposure	0.301	2	0.151	3.516	**<0.05**
Age*Task Order	0.001	2	0.000	0.009	n.s.
Instructions*Exposure	0.036	1	0.036	0.834	n.s.
Instructions*Task Order	0.067	1	0.067	1.572	n.s.
Exposure*Task Order	0.037	1	0.037	0.866	n.s.
Age*Instructions*Exposure	0.013	2	0.006	0.148	n.s.
Age*Instructions*Task Order	0.011	2	0.006	0.133	n.s.
Age*Exposure*Task Order	0.049	2	0.025	0.575	n.s.
Instructions*Exposure*T.O.	0.049	1	0.049	1.141	n.s.
Age*Instructions*Exp.*T.O.	0.124	2	0.062	1.446	n.s.
Error	5.925	274	0.022		
Drawing Order (D.O.)	0.462	1	0.462	21.362	**<0.001**
Age*Drawing Order	0.088	2	0.044	2.031	n.s.
Instructions*Drawing Order	0.005	1	0.005	0.236	n.s.
Exposure*Drawing Order	0.005	1	0.005	0.212	n.s.
Task Order*Drawing Order	0.000	1	0.000	0.002	n.s.
Age*Inst.*Drawing Order	0.060	2	0.030	1.384	n.s.
Age*Exposure*Drawing Order	0.002	2	0.001	0.048	n.s.
Age*Task Order*D.O.	0.014	2	0.007	0.324	n.s.
Instructions*Exposure*D.O.	0.198	1	0.198	9.177	<0.01
Instructions*Task Order*D.O.	0.030	1	0.030	1.409	n.s.
Exposure*Task Order*D.O.	0.063	1	0.063	2.892	n.s.
Age*Instructions*Exp.*D.O.	0.030	2	0.015	0.699	n.s.
Age*Instructions*T.O.*D.O.	0.016	2	0.008	0.380	n.s.
Age*Exposure*T.O.*D.O.	0.023	2	0.011	0.523	n.s.
Instructions*Exp.*T.O.*D.O.	0.039	1	0.039	1.785	n.s.
Age*Inst.*Exposure*T.O.*D.O.	0.290	2	0.145	6.705	<0.01

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

Drawing order significantly interacted with exposure and instruction (F(1,274)=9.18 p<.01). Follow-up analysis showed that on the second drawing the ES condition produced more looking than the SS condition (Scheffe F(1,274)=29.12 p<.05). A five way interaction between age, instruction, exposure, task order and drawing order (F(2,274)=6.71 p<.01) showed no significant differences between individual means using Scheffe's method of multiple comparison on means (ps>.05).

TABLE E.7 HIDDEN HANDLE TASK - SUMMARY ANOVA TABLE FOR LOOKING TIME BY DRAWING REALISM (CONTINUOUS AND SHORT EXPOSURES)

SOURCE	S.S.	D.F.	M.S.	F.	P.
Error	3.546	262	0.014		
Age	0.287	2	0.144	10.610	<0.001
Instructions (Inst.)	0.439	1	0.439	32.396	<0.001
Exposure (Exp.)	0.009	1	0.009	0.683	n.s.
Drawing Realism	0.112	1	0.112	8.273	**<0.01**
Age*Instructions	0.058	2	0.029	2.129	n.s.
Age*Exposure	0.012	2	0.006	0.457	n.s.
Age*Realism	0.023	2	0.011	0.837	**n.s.**
Instructions*Exposure	0.008	1	0.008	0.613	n.s.
Instructions*Realism	0.043	1	0.043	3.189	n.s.
Exposure*Realism	0.005	1	0.005	0.339	n.s.
Age*Instructions*Exposure	0.024	2	0.012	0.883	n.s.
Age*Instructions*Realism	0.100	2	0.050	3.682	<0.05
Age*Exposure*Realism	0.017	2	0.009	0.637	n.s.
Instructions*Exposure*Realism	0.005	1	0.005	0.349	n.s.
Age*Instructions*Exp.*Realism	0.024	2	0.012	0.887	n.s.

n.s. = non-significant effect at $p>0.05$.
The main findings are highlighted.

Subsidiary Findings

There was a significant main effect of age ($F(2,262)=10.61$ $p<.001$) where the 4-year-olds looked less than the 6- and 8-year-olds (Scheffe ps<.01). Follow-up analysis of the significant interaction between age, instruction and drawing realism ($F(2,262)=3.68$ $p>.05$) showed no significant differences between the intellectually and visually realistic drawers for both instructions and for all three ages (Scheffe ps>.05).

TABLE E.8 **SUMMARY ANOVA TABLE FOR LOOKING TIME (CONTINUOUS EXPOSURE)**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	14.967	137	0.109			
Age	2.372	2	1.186	10.854	**<0.001**	
Instructions (Inst.)	1.045	1	1.045	9.563	**<0.01**	
Task Order (T.O.)	0.003	1	0.003	0.030	n.s.	
Age*Instructions	0.695	2	0.348	3.181	**<0.05**	
Age*Task Order	0.125	2	0.062	0.572	n.s.	
Inst.*Task Order	0.151	1	0.151	1.383	n.s	
Age*Inst.*Task Order	0.160	2	0.080	0.730	n.s.	
Error	3.288	137	0.024			
Drawing Order (D.O.)	0.717	1	0.717	29.887	**<0.001**	
Age*Drawing Order	0.089	2	0.045	1.860	n.s.	
Instructions*D.O.	0.127	1	0.127	5.300	<0.05	
Task Order*D.O.	0.194	1	0.194	8.072	<0.01	
Age*Instructions*D.O.	0.041	2	0.021	0.862	n.s.	
Age*Task Order*D.O.	0.085	2	0.042	1.767	n.s	
Instructions*T.O.*D.O.	0.000	1	0.000	0.017	n.s.	
Age*Inst.*T.O.*D.O.	0.060	2	0.030	1.247	n.s.	
Error	23.497	411	0.057			
Look Type (L.T.)	76.944	3	25.648	448.629	**<0.001**	**<0.001**
Age*Look Type	2.581	6	0.430	7.524	**<0.001**	**<0.001**
Inst.*Look Type	0.846	3	0.282	4.933	**<0.01**	**<0.01**
Task Order*Look Type	0.090	3	0.030	0.526	n.s.	n.s.
Age*Instructions*L.T.	0.585	6	0.097	1.704	n.s	n.s
Age*Task Order*L.T.	0.493	6	0.082	1.437	n.s.	n.s.
Instructions*T.O.*L.T.	0.099	3	0.033	0.579	n.s.	n.s.
Age*Inst.*T.O.*L.T.	0.195	6	0.032	0.568	n.s.	n.s.
Error	10.045	411	0.024			
D.O.*Look Type	0.625	3	0.208	8.528	<0.001	<0.001
Age*D.O.*Look Type	0.103	6	0.017	0.702	n.s.	n.s.
Instructions*D.O.*L.T.	0.069	3	0.023	0.945	n.s.	n.s.
Task Order*D.O.*L.T.	0.698	3	0.233	9.521	<0.001	<0.001
Age*Inst.*D.O.*L.T.	0.051	6	0.008	0.346	n.s.	n.s.
Age*T.O.*D.O.*L.T.	0.595	6	0.099	4.055	**<0.01**	**<0.01**
Inst.*T.O.*D.O.*L.T.	0.059	3	0.020	0.802	n.s.	n.s.
Age*Inst.*Task Order* Drawing Order*L.T.	0.292	6	0.049	1.990	>n.s.	>n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

TABLE E.9 **HIDDEN HANDLE TASK - SUMMARY ANOVA TABLE FOR LOOKING TIME BY DRAWING REALISM (CONTINUOUS EXPOSURE)**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	8.357	126	0.066			
Age	0.051	2	0.025	0.383	n.s.	
Instructions (Inst.)	0.167	1	0.167	2.520	n.s.	
Realism (Rm.)	0.150	1	0.150	2.264	**n.s.**	
Age*Instructions	0.084	2	0.042	0.636	n.s.	
Age*Realism	0.302	2	0.151	2.277	n.s.	
Instructions*Realism	0.013	1	0.013	0.192	n.s.	
Age*Inst.*Realism	0.288	2	0.144	2.172	n.s.	
Error	15.877	378	0.042			
Look Type (L.T.)	24.556	3	8.185	194.876	<0.001	<0.001
Age*Look Type	0.422	6	0.070	1.673	n.s.	n.s.
Inst.*Look Type	0.154	3	0.051	1.220	n.s.	n.s.
Realism*Look Type	0.471	3	0.157	3.734	**<0.05**	**<0.05**
Age*Instructions*L.T.	0.292	6	0.049	1.159	n.s.	n.s.
Age*Realism*L.T.	0.382	6	0.064	1.518	**n.s.**	**n.s.**
Inst.*Realism*L.T.	0.050	3	0.017	0.394	n.s.	n.s.
Age*Inst.*Realism*L.T.	0.048	6	0.008	0.191	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

This ANOVA showed a highly significant main effect of look type ($F(2,288)=194.88$ $p<.001$*) where the 'beginning' looks were significantly greater than the other look types, and the 'within' looks were greater than the 'between' and 'end' looks (Scheffe ps<.001).

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

APPENDIX F

The following tables detail the Log-Linear model selection precedure for the drawing data for Study 3 (Chapter 4). The Likelihood Ratios for Chi-Square Change show how the chi-square statistic for the overall model would change if that particular simple effect was removed from the model. Therefore in a series of steps, the non-significant simple effect with the lowest Likelihood Ratio is removed and the model is recomputed. The final model selected therefore includes only those effects that would make a significant reduction to the statistic if removed.

When an appropriate model is selected the residuals (i.e. the difference between the observed frequencies and the expected frequencies based on the selected model) and the standardised residuals (residuals / square-root of the expected frequencies) are calculated. If the selected model fits the observed data adequately, these residuals should be fairly small. If the standardised residuals are greater than 1.96, or less than -1.96 this would suggest that the final model does not provide an adequate fit or explanation of the observed frequences.

AGE EFFECTS

TABLE F.1 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING AGE, INSTRUCTIONS AND DRAWING REALISM (NON-OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Age*Instructions*Realism	0.150	2	n.s.
2	**Age*Realism,**	62.832	2	**<0.001**
	Age*Instructions,	1.807	2	n.s.
	Instructions*Realism	3.828	1	=0.05
3	**Age*Realism,**	61.109	2	**<0.001**
	Instructions*Realism	2.105	1	n.s.
4	**Age*Realism,**	61.109	2	**<0.001**
	Instructions	0.025	1	n.s.
5	**Age*Realism**	61.109	2	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.2 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING AGE, PRESENTATION ORDER AND DRAWING REALISM (NON-OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Age*Order*Realism	0.636	2	n.s.
2	**Age*Realism,**	61.591	2	**<0.001**
	Age*Order,	0.584	2	n.s.
	Order*Realism	0.941	1	n.s.
3	**Age*Realism,**	61.109	2	**<0.001**
	Order*Realism	0.460	1	n.s.
4	**Age*Realism,**	61.109	2	**<0.001**
	Order	0.099	1	n.s.
5	**Age*Realism**	61.109	2	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.3 OBSERVED, EXPECTED FREQUENCIES AND RESIDUALS BASED ON THE SELECTED MODEL OF AGE * DRAWING REALISM (NON-OCCLUSION TASK)

Age	Instructions/ Realism †		Observed Frequency	Expected Frequency	Residuals	Standardised Residuals
Four	Visual	Standard	1.00	2.00	-1.00	-0.707
		Explicit	3.00	2.00	+1.00	+0.707
	Intell.	Standard	23.00	22.50	+0.50	+0.105
		Explicit	22.00	22.50	-0.50	-0.105
Six	Visual	Standard	8.00	10.50	-2.50	-0.772
		Explicit	13.00	10.50	+2.50	+0.772
	Intell.	Standard	19.00	17.50	+1.50	+0.359
		Explicit	16.00	17.50	-1.50	-0.359
Eight	Visual	Standard	21.00	22.50	-1.50	-0.316
		Explicit	24.00	22.50	+1.50	+0.316
	Intell.	Standard	8.00	6.00	+2.00	+0.816
		Explicit	4.00	6.00	-2.00	-0.816

† Intell. = Intellectual Realism.

TABLE F.4 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING AGE, INSTRUCTIONS AND DRAWING REALISM (TOTAL OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Age*Instructions*Realism	1.692	2	n.s.
2	**Age*Realism,** Age*Instructions, Instructions*Realism	42.569 0.648 1.766	2 2 1	**<0.001** n.s. n.s.
3	**Age*Realism,** Instructions*Realism	41.956 1.154	2 1	**<0.001** n.s.
4	**Age*Realism,** Instructions	41.956 0.000	2 1	**<0.001** n.s.
5	**Age*Realism**	41.956	2	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.5 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING AGE, PRESENTATION ORDER AND DRAWING REALISM (TOTAL OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Age*Order*Realism	1.293	2	n.s.
2	**Age*Realism,** Age*Order, Order*Realism	42.216 0.295 2.168	2 2 1	**<0.001** n.s. n.s.
3	**Age*Realism,** Order*Realism	41.956 1.908	2 1	**<0.001** n.s.
4	**Age*Realism,** Order	41.956 0.000	2 1	**<0.001** n.s.
5	**Age*Realism**	41.956	2	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.6 OBSERVED, EXPECTED FREQUENCIES AND RESIDUALS BASED ON THE SELECTED MODEL OF AGE * DRAWING REALISM (TOTAL OCCLUSION TASK)

Age	Instructions/ Realism †		Observed Frequency	Expected Frequency	Residuals	Standardised Residuals
Four	Visual	Standard	7.00	6.50	+0.50	+0.196
		Explicit	6.00	6.50	-0.50	-0.196
	Intell.	Standard	21.00	21.00	+0.00	+0.000
		Explicit	21.00	21.00	+0.00	+0.000
Six	Visual	Standard	21.00	17.50	+3.50	+0.837
		Explicit	14.00	17.50	-3.50	-0.837
	Intell.	Standard	9.00	12.50	-3.50	-0.990
		Explicit	16.00	12.50	+3.50	+0.990
Eight	Visual	Standard	23.00	23.50	-0.50	-0.103
		Explicit	24.00	23.50	+0.50	+0.103
	Intell.	Standard	5.00	5.00	+0.00	+0.000
		Explicit	5.00	5.00	+0.00	+0.000

† Intell. = Intellectual Realism.

TABLE F.7 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING AGE AND DRAWING REALISM (PARTIAL OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	**Age*Realism**	25.050	2	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.

† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.

The significant effect is highlighted.

Note: Due to the selection of the saturated model, the expected frequencies were equal to the observed frequencies, and therefore the residuals and standardised residuals were zero.

TABLE F.8 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING PRESENTATION ORDER AND DRAWING REALISM (TOTAL OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Order*Realism	2.815	1	n.s.
2	Order, **Realism**	0.018 16.092	1 1	n.s. **<0.001**
3	**Realism**	16.092	1	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.9 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING INSTUCTIONS AND DRAWING REALISM (TOTAL OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Instructions*Realism	0.059	1	n.s.
2	Instructions, **Realism**	0.018 16.092	1 1	n.s. **<0.001**
3	**Realism**	16.092	1	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.10 OBSERVED, EXPECTED FREQUENCIES AND RESIDUALS BASED ON THE SELECTED MODEL OF DRAWING REALISM (TOTAL OCCLUSION TASK)

Order Realism	Observed Frequency	Expected Frequency	Residuals	Standardised Residuals
Second (Condition 1)				
Visual	9.00	6.50	+2.50	+0.981
Intellectual	18.00	21.00	-3.00	-0.655
First (Condition 2)				
Visual	4.00	6.50	-2.50	-0.981
Intellectual	24.00	21.00	+3.00	+0.655

TABLE F.11 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING PRESENTATION ORDER, INSTRUCTIONS AND DRAWING REALISM (NON-OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Order*Instructions*Realism	3.045	1	n.s.
2	Order*Instructions, Order*Realism, Instruction*Realism	0.020 0.636 1.336	1 1 1	n.s. n.s. n.s.
3	Order*Realism, Instruction*Realism	0.688 1.388	1 1	n.s. n.s.
4	Instruction*Realism, Order	1.388 0.000	1 1	n.s. n.s.
5	Instruction*Realism	1.388	1	n.s.
6	Instruction Realism	0.071 3.537	1 1	n.s. n.s.
7	Realism	3.537	1	n.s.

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.12 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING PRESENTATION ORDER, INSTRUCTIONS AND DRAWING REALISM (TOTAL OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Order*Instructions*Realism	0.086	1	n.s.
2	Order*Instructions, Order*Realism, Instruction*Realism	0.004 0.073 3.400	1 1 1	n.s. n.s. n.s.
3	Order*Realism, Instruction*Realism	0.069 3.396	1 1	n.s. n.s.
4	Instruction*Realism, Order	3.396 0.000	1 1	n.s. n.s.
5	Instruction*Realism	3.396	1	n.s.
6	Instruction Realism	0.000 1.674	1 1	n.s. n.s.
7	Realism	1.674	1	n.s.

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.13 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING PRESENTATION ORDER AND DRAWING REALISM (NON-OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Order*Realism	0.005	1	n.s.
2	Order, **Realism**	0.018 20.348	1 1	n.s. **<0.001**
3	**Realism**	20.348	1	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.14 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING INSTUCTIONS AND DRAWING REALISM (NON-OCCLUSION TASK)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Instructions*Realism	1.542	1	n.s.
2	Instructions, **Realism**	0.018 20.348	1 1	n.s. **<0.001**
3	**Realism**	20.348	1	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.15 OBSERVED, EXPECTED FREQUENCIES AND RESIDUALS BASED ON THE SELECTED MODEL OF DRAWING REALISM (NON-OCCLUSION TASK)

Order Realism	Observed Frequency	Expected Frequency	Residuals	Standardised Residuals
First (Condition 1)				
Visual	22.00	22.50	-0.500	-0.105
Intellectual	6.00	6.00	+0.000	+0.000
Second (Condition 2)				
Visual	23.00	22.50	+0.500	+0.105
Intellectual	6.00	6.00	+0.000	+0.000

CONDITION EFFECTS (CONDITIONS 1, 2 AND 3)

TABLE F.16 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING CONDITION, INSTRUCTIONS AND DRAWING REALISM (SIX-YEAR-OLDS)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	**Condition*Instructions* Realism**	6.024	2	**<0.05**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

Note: Due to the selection of the saturated model, the expected frequencies were equal to the observed frequencies, and therefore the residuals and standardised residuals were zero.

TABLE F.17 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING CONDITION AND DRAWING REALISM (EIGHT-YEAR-OLDS)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Condition*Realism	1.654	1	n.s.
2	Condition, **Realism**	0.023 20.625	1 1	n.s. **<0.001**
3	**Realism**	20.625	1	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE F.18 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING INSTRUCTION AND DRAWING REALISM (EIGHT-YEAR-OLDS)

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Instruction*Realism	0.092	1	n.s.
2	Instruction, **Realism**	0.106 20.625	1 1	n.s. **<0.001**
3	**Realism**	20.625	1	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.

† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.

The significant effects are highlighted.

TABLE F.19 OBSERVED, EXPECTED FREQUENCIES AND RESIDUALS BASED ON THE SELECTED MODEL OF DRAWING REALISM (EIGHT-YEAR-OLDS)

Condition Realism	Observed Frequency	Expected Frequency	Residuals	Standardised Residuals
Non-Occlusion				
Visual	22.00	21.00	+1.000	+0.218
Intellectual	6.00	7.33	-1.333	-0.492
Total Occlusion				
Visual	22.00	21.00	+1.000	+0.218
Intellectual	6.00	7.33	-1.333	-0.492
Partial Occlusion				
Visual	19.00	21.00	-2.000	-0.436
Intellectual	10.00	7.33	+2.667	+0.985

APPENDIX G

Summary ANOVA tables and details of subsidiary findings for Study 3 (Chapter 4).

TABLE G.1 **SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS CONDITIONS 1 AND 2**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	6.595	168	0.039			
Age	2.457	2	1.228	31.290	**<0.001**	
Condition	0.012	1	0.012	0.306	n.s.	
Instruction (Inst.)	0.899	1	0.899	22.898	**<0.001**	
Age*Condition	0.040	2	0.020	0.507	n.s.	
Age*Instruction	0.104	2	0.052	1.329	n.s.	
Condition*Instruction	0.010	1	0.010	0.250	n.s.	
Age*Condition*Instruction	0.002	2	0.001	0.025	n.s.	
Error	2.281	168	0.014			
Drawing Order (D.O.)	0.658	1	0.658	48.435	**<0.001**	
Age*Drawing Order	0.025	2	0.013	0.932	n.s.	
Condition*D.O.	0.008	1	0.008	0.582	n.s.	
Instruction*D.O.	0.105	1	0.105	7.753	**<0.01**	
Age*Condition*D.O.	0.012	2	0.006	0.448	n.s.	
Age*Instruction*D.O.	0.011	2	0.006	0.419	n.s.	
Condition*Inst.*D.O.	0.002	1	0.002	0.160	n.s.	
Age*Condition*Inst.*D.O.	0.032	2	0.016	1.171	n.s.	
Error	14.571	504	0.029			
Look Type (L.T.)	43.722	3	14.574	504.108	**<0.001**	**<0.001**
Age*Look Type	1.509	6	0.251	8.697	**<0.001**	**<0.001**
Condition*Look Type	0.072	3	0.024	0.834	n.s.	n.s.
Inst.*Look Type	0.292	3	0.097	3.365	**<0.05**	**<0.05**
Age*Condition*Look Type	0.085	6	0.014	0.491	n.s.	n.s.
Age*Instruction*L.T.	0.196	6	0.033	1.128	n.s.	n.s.
Condition*Inst.*Look Type	0.043	3	0.014	0.499	n.s.	n.s.
Age*Condition*Inst.*L.T.	0.035	6	0.006	0.204	n.s.	n.s.
Error	7.951	504	0.016			
D.O.*Look Type	0.380	3	0.127	8.020	**<0.001**	**<0.001**
Age*D.O.*Look Type	0.156	6	0.026	1.643	n.s.	n.s.
Condition*D.O.*Look Type	0.115	3	0.038	2.425	n.s.	n.s.
Instruction*D.O.*L.T.	0.081	3	0.027	1.701	n.s.	n.s.
Age*Condition*D.O.*L.T.	0.055	6	0.009	0.580	n.s.	n.s.
Age*Inst.*D.O.*Look Type	0.106	6	0.018	1.122	n.s.	n.s.
Cond.*Inst.*D.O.*L.T.	0.045	3	0.015	0.950	n.s.	n.s.
Age*Condition*Instruction *D.O.*Look Type	0.044	6	0.007	0.461	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

TABLE G.2 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS BY DRAWING REALISM (NON- AND TOTAL OCCLUSION)

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	4.079	150	0.027			
Age	0.138	2	0.069	2.540	n.s.	
Condition	0.026	1	0.026	0.944	n.s.	
Drawing Realism						
Non-Occlusion (N.O.R.)	0.102	1	0.102	3.739	**0.055**	
Age*Condition	0.009	2	0.004	0.159	n.s.	
Age*N.O. Realism	0.018	2	0.009	0.333	n.s.	
Condition*N.O. Realism	0.013	1	0.013	0.482	n.s.	
Age*Condition*N.O. Realism	0.031	2	0.016	0.578	n.s.	
Error	9.762	450	0.022			
Look Type (L.T.)	8.354	3	2.785	128.363	<0.001	<0.001
Age*Look Type	0.337	6	0.056	2.591	n.s.	n.s.
Condition*Look Type	0.014	3	0.005	0.214	n.s.	n.s.
N.O. Realism*Look Type	0.230	3	0.077	3.538	**<0.05**	**<0.05**
Age*Condition*Look Type	0.080	6	0.013	0.611	n.s.	n.s.
Age*N.O.R.*Look Type	0.128	6	0.021	0.981	n.s.	n.s.
Condition*N.O.R.*Look Type	0.078	3	0.026	1.193	n.s.	n.s.
Age*Condition*N.O.R.*L.T.	0.143	6	0.024	1.100	n.s.	n.s.
Error	5.335	163	0.033			
Age	0.930	2	0.465	14.201	<0.001	
Condition	0.230	1	0.230	7.012	<0.01	
Drawing Realism						
Total Occlusion (T.O.R.)	0.023	1	0.023	0.698	**n.s.**	
Age*Condition	0.061	2	0.030	0.930	n.s.	
Age*T.O. Realism	0.010	2	0.005	0.153	n.s.	
Condition*T.O. Realism	0.037	1	0.037	1.115	n.s.	
Age*Condition*T.O.R.	0.030	2	0.015	0.462	n.s.	
Error	11.472	489	0.023			
Look Type (L.T.)	14.347	3	4.782	203.843	<0.001	<0.001
Age*Look Type	0.459	6	0.076	3.258	<0.01	<0.01
Condition*Look Type	0.092	3	0.031	1.301	n.s.	n.s.
T.O. Realism.*Look Type	0.145	3	0.048	2.060	**n.s.**	**n.s.**
Age*Condition*Look Type	0.065	6	0.011	0.459	n.s.	n.s.
Age*T.O. Realism*Look Type	0.100	6	0.017	0.713	n.s.	n.s.
Condition*T.O. Realism*L.T.	0.051	3	0.017	0.732	n.s.	n.s.
Age*Condition*T.O.R.*L.T.	0.096	6	0.016	0.683	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

For the Non-Occlusion model, the ANOVA also showed a highly significant main effect of look type ($F(3,412)=128.36$ $p<.001$*) and an interaction between look type and age ($F(5,412)=2.59$ $p<.05$*). Follow-up analysis revealed significant differences between all look types (Scheffe ps<.05). The four- and six-year-olds looked more at the model at the 'beginning' of the task compared to all other look types, while the eight-year-olds also looked more 'within' and 'between' than at the 'end' of the task (Scheffe ps<.05).

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

For the Total Occlusion model, the ANOVA showed a significant a main effect of age ($F(2,163)=14.20$ $p<.001$) in that the 4-year-olds looked less than the 6- and 8-year-olds, and a main effect of condition ($F(1,163)=7.01$ $p<.01$) where greater looking occurred when this task was presented first (Condition 2) compared to being presented second (Condition 1). The ANOVA also showed a highly significant main effect of look type ($F(3,456)=203.84$ $p<.001$*) and an interaction between look type and age ($F(6,456)=3.26$ $p<.01$*). The 'beginning' looks were greater than all other look types, and the 'between' looks were greater than the 'end' looks, with this latter significant difference being produced by the eight-year-olds alone (Scheffe $F(6,456)=25.06$ $p<.05$*).

TABLE G.3 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS CONDITIONS 1, 2 AND 3

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	7.703	252	0.031			
Age	1.805	2	0.903	29.524	<0.001	
Condition (Cond.)	0.020	2	0.010	0.331	**n.s.**	
Instruction (Inst.)	0.622	1	0.622	20.354	**<0.001**	
Age*Condition	0.164	4	0.041	1.342	n.s.	
Age*Instruction	0.031	2	0.016	0.513	n.s.	
Condition*Inst.	0.198	2	0.099	3.233	**<0.05**	
Age*Condition*Inst.	0.095	4	0.024	0.777	n.s.	
Error	19.766	756	0.026			
Look Type (L.T.)	39.299	3	13.100	501.024	**<0.001**	**<0.001**
Age*Look Type	1.872	6	0.312	11.933	**<0.001**	**<0.001**
Condition*Look Type	0.106	6	0.018	0.677	n.s.	n.s.
Inst.*Look Type	0.261	3	0.087	3.323	**<0.05**	**<0.05**
Age*Condition*L.T.	0.270	12	0.022	0.860	n.s.	n.s.
Age*Instruction*L.T.	0.261	6	0.044	1.664	n.s.	n.s.
Condition*Inst.*L.T.	0.100	6	0.017	0.636	n.s.	n.s.
Age*Cond.*Inst.*L.T.	0.151	12	0.013	0.482	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

Condition interacted with the instructions ($F(2,252)=3.23$ $p<.05$), although follow-up analyis revealed no significant differences. However, inspection of the means detailed in Table G.4 shows that the explicit instructions showed high levels of looking in all three Conditions, with Condition 2 (Total Occlusion) showing the greatest difference between the standard and explicit instructions.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE G.4 **MEAN NUMBER OF LOOKS PER INSTRUCTION AND CONDITION**

CONDITION INSTRUCTION	CONDITION 1 (NON-OCCLUSION)	CONDITION 2 (TOTAL OCCLUSION)	CONDITION 3 (PARTIAL OCCLUSION)	TOTAL MEAN
STANDARD	0.17 (0.77)	0.18 (0.79)	0.20 (0.98)	**0.19** **(0.84)**
EXPLICIT	0.22 (1.22)	0.25 (1.18)	0.21 (1.03)	**0.23** **(0.14)**
TOTAL MEAN	**0.20** **(0.99)**	**0.22** **(0.98)**	**0.21** **(1.01)**	

Untransformed means (number of looks) are shown in parentheses.

TABLE G.5 **SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS BY DRAWING REALISM ACROSS ALL THREE CONDITIONS**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	7.689	222	0.035			
Age	0.203	2	0.102	2.931	n.s.	
Condition	0.047	2	0.024	0.684	n.s.	
Drawing Realism	0.043	1	0.043	1.233	**n.s.**	
Age*Condition	0.193	4	0.048	1.395	n.s.	
Age*Realism	0.023	2	0.012	0.336	n.s.	
Condition*Realism	0.188	2	0.094	2.720	n.s.	
Age*Condition*Realism	0.083	4	0.021	0.601	n.s.	
Error	17.916	666	0.027			
Look Type (L.T.)	13.652	3	4.551	169.167	<0.001	<0.001
Age*Look Type	0.678	6	0.113	4.198	<0.001	<0.001
Condition*Look Type	0.175	6	0.029	1.082	n.s.	n.s.
Realism*Look Type	0.076	3	0.025	0.940	**n.s.**	**n.s.**
Age*Condition*L.T.	0.360	12	0.030	1.115	n.s.	n.s.
Age*Realism*L.T.	0.077	6	0.013	0.476	n.s.	n.s.
Condition*Realism*L.T.	0.204	6	0.034	1.262	n.s.	n.s.
Age*Condition* Realism*Look Type	0.368	12	0.031	1.141	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The ANOVA also showed a highly significant main effect of look type ($F(3,602)=169.17$ $p<.001$*) and interaction between look type and age ($F(5,602)=4.20$ $p<.001$*). The 'beginning' looks were greater than all other look types, and the 'within' and 'between' looks were greater than the 'end' looks, with these latter significant differences being produced by the eight-year-olds alone (Scheffe ps<.05).

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE G.6 SUMMARY ANOVA TABLE FOR LOOKING TIME CONDITIONS 1 AND 2

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	7.224	168	0.043			
Age	4.050	2	2.025	47.097	**<0.001**	
Condition	0.019	1	0.019	0.440	n.s.	
Instruction (Inst.)	1.142	1	1.142	26.554	**<0.001**	
Age*Condition	0.051	2	0.026	0.594	n.s.	
Age*Instruction	0.165	2	0.083	1.922	n.s.	
Condition*Instruction	0.035	1	0.035	0.813	n.s.	
Age*Condition*Inst.	0.045	2	0.023	0.528	n.s.	
Error	2.684	168	0.016			
Drawing Order (D.O.)	0.571	1	0.571	35.737	**<0.001**	
Age*Drawing Order	0.070	2	0.035	2.194	n.s.	
Condition*D.O.	0.095	1	0.095	5.933	**<0.05**	
Instruction*D.O.	0.159	1	0.159	9.977	**<0.01**	
Age*Condition*D.O.	0.058	2	0.029	1.819	n.s.	
Age*Instruction*D.O.	0.014	2	0.007	0.436	n.s.	
Condition*Inst.*D.O.	0.002	1	0.002	0.152	n.s.	
Age*Condition*Inst.*D.O.	0.022	2	0.011	0.686	n.s.	
Error	15.495	504	0.031			
Look Type (L.T.)	131.873	3	43.958	1429.810	**<0.001**	**<0.001**
Age*Look Type	1.737	6	0.289	9.416	**<0.001**	**<0.001**
Condition*Look Type	0.059	3	0.020	0.643	n.s.	n.s.
Inst.*Look Type	0.487	3	0.162	5.277	**<0.01**	**<0.01**
Age*Condition*Look Type	0.069	6	0.012	0.376	n.s.	n.s.
Age*Instruction*L.T.	0.193	6	0.032	1.047	n.s.	n.s.
Condition*Inst.*L.T.	0.256	3	0.085	2.775	<0.05	<0.05
Age*Condition*Inst.*L.T.	0.083	6	0.014	0.452	n.s.	n.s.
Error	8.071	504	0.016			
D.O.*Look Type	0.405	3	0.135	8.430	<0.001	<0.001
Age*D.O.*Look Type	0.125	6	0.021	1.299	n.s.	n.s.
Condition*D.O.*Look Type	0.007	3	0.002	0.139	n.s.	n.s.
Instruction*D.O.*L.T.	0.067	3	0.022	1.399	n.s.	n.s.
Age*Condition*D.O.*L.T.	0.131	6	0.022	1.362	n.s.	n.s.
Age*Inst.*D.O.*Look Type	0.088	6	0.015	0.918	n.s.	n.s.
Condition*Inst.*D.O.*L.T.	0.049	3	0.016	1.014	n.s.	n.s.
Age*Condition*Inst.* D.O.*Look Type	0.092	6	0.015	0.959	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The ANOVA showed an interaction between condition, instruction and look type ($F(3,449)= 2.77$ $p<.05$*). However follow-up analysis only revealed that the 'beginning' looks were greater than all other look types for each instruction and condition combination.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE G.7 **SUMMARY ANOVA TABLE FOR LOOKING TIME BY DRAWING REALISM (NON- AND TOTAL OCCLUSION)**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	4.380	150	0.029			
Age	0.205	2	0.102	3.504	<0.05	
Condition	0.010	1	0.010	0.328	n.s.	
Drawing Realism						
Non-Occlusion(N.O.R.)	0.190	1	0.190	6.513	**<0.05**	
Age*Condition	0.042	2	0.021	0.725	n.s.	
Age*N.O. Realism	0.047	2	0.024	0.808	**n.s.**	
Condition*N.O. Realism	0.000	1	0.000	0.005	n.s.	
Age*Condition*N.O. Realism	0.074	2	0.037	1.274	n.s.	
Error	9.954	450	0.022			
Look Type (L.T.)	23.675	3	7.892	356.757	<0.001	<0.001
Age*Look Type	0.536	6	0.089	4.041	<0.01	<0.01
Condition*Look Type	0.012	3	0.004	0.179	n.s.	n.s.
N.O. Realism*Look Type	0.103	3	0.034	1.545	n.s.	n.s.
Age*Condition*Look Type	0.149	6	0.025	1.123	n.s.	n.s.
Age*N.O. Realism*Look Type	0.078	6	0.013	0.589	n.s.	n.s.
Condition*N.O. Realism*L.T.	0.066	3	0.022	1.002	n.s.	n.s.
Age*Condition*N.O.R.*L.T.	0.235	6	0.039	1.773	n.s.	n.s.
Error	6.212	163	0.038			
Age	1.169	2	0.584	15.335	<0.001	<0.001
Condition	0.329	1	0.329	8.625	<0.01	<0.01
Drawing Realism						
Total-Occlusion(T.O.R.)	0.080	1	0.080	2.093	**n.s.**	**n.s.**
Age*Condition	0.090	2	0.040	1.044	n.s.	n.s.
Age*T.O. Realism	0.025	2	0.012	0.328	n.s.	n.s.
Condition*T.O. Realism	0.034	1	0.034	0.899	n.s.	n.s.
Age*Condition*T.O. Realism	0.011	2	0.006	0.148	n.s.	n.s.
Error	12.743	489	0.026			
Look Type (L.T.)	46.506	3	15.502	594.880	<0.001	<0.001
Age*Look Type	0.593	6	0.099	3.794	<0.01	<0.01
Condition*Look Type	0.233	3	0.078	2.988	<0.05	<0.05
T.O. Realism*Look Type	0.102	3	0.034	1.299	n.s.	n.s.
Age*Condition*Look Type	0.056	6	0.009	0.358	n.s.	n.s.
Age*T.O. Realism*Look Type	0.144	6	0.024	0.920	n.s.	n.s.
Condition*T.O. Realism*L.T.	0.019	3	0.006	0.243	n.s.	n.s.
Age*Condition*T.O.R.*L.T.	0.057	6	0.009	0.363	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

For the Non-Occlusion model, there were main effects of age ($F(2,150)=3.50$ $p<.05$), look type ($F(3,406)=356.76$ $p<.001$*) and an interaction between the two ($F(5,406)=4.04$ $p<.01$*). The 4-year-olds looked less than the 6-year-olds (Scheffe $p<.001$), and the 'beginning' looks were greater than all other look types, and the 'between' looks were greater than the 'within' and 'end' looks (Scheffe ps<.05). The interaction only revealed that the 'beginning' looks were greater than all other look types (Scheffe ps<.01).

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

For the Total Occlusion model, there were main effects of age (F(2,163)=15.33 p<.001) and condition (F(1,163)=8.62 p<.01). The 4-year-olds looked less than the 6- and 8-year-olds, and greater looking occurred when this task was presented first (Condition 2) compared to being presented second (Condition 1). The ANOVA also showed a highly significant main effect of look type (F(3,464)=5.94.88 p<.001*), an interaction between look type and age (F(6,464)=3.79 p<.01*), and an interaction between look type and drawing order (F(3,464)=2.99 p<.05*). Follow-up analysis revealed significant differences between each look type (ps<.05). The two interactions showed that while all ages, and both drawing orders showed the 'beginning' looks to be higher than all other look types, only for the 8-year-olds, and only when this task was presented first, were the 'between' looks greater than the 'end' looks (Scheffe ps<.05).

<u>TABLE G.8</u> <u>SUMMARY ANOVA TABLE FOR LOOKING TIME CONDITIONS 1, 2 AND 3</u>

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	7.892	252	0.031			
Age	3.957	2	1.979	63.181	**<0.001**	
Condition (Cond.)	0.134	2	0.067	2.140	**n.s.**	
Instruction(Inst.)	0.908	1	0.908	29.009	**<0.001**	
Age*Condition	0.157	4	0.039	1.253	n.s.	
Age*Instruction	0.090	2	0.045	1.429	n.s.	
Condition*Inst.	0.230	2	0.115	3.675	**<0.05**	
Age*Condition*Inst.	0.078	4	0.019	0.622	n.s.	
Error	19.756	756	0.026			
Look Type (L.T.)	106.764	3	35.588	1361.831	**<0.001**	**<0.001**
Age*Look Type	2.175	6	0.362	13.869	**<0.001**	**<0.001**
Condition*Look Type	0.073	6	0.012	0.466	n.s.	n.s.
Inst.*Look Type	0.378	3	0.126	4.825	**<0.01**	**<0.01**
Age*Condition*L.T.	0.365	12	0.030	1.165	n.s.	n.s.
Age*Instruction*L.T.	0.250	6	0.042	1.592	n.s.	n.s.
Condition*Inst.*L.T.	0.230	6	0.038	1.469	n.s.	n.s.
Age*Cond.*Inst.*L.T.	0.274	12	0.022	0.873	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE G.9 **SUMMARY ANOVA TABLE FOR LOOKING TIME BY REALISM ACROSS ALL THREE CONDITIONS**

SOURCE	S.S.	D.F.	M.S.	F.	P.	GG P.†
Error	7.916	222	0.036			
Age	0.408	2	0.204	5.724	<0.01	
Condition (Cond.)	0.090	2	0.045	1.258	n.s.	
Drawing Realism	0.179	1	0.179	5.022	**<0.05**	
Age*Condition	0.163	4	0.041	1.141	n.s.	
Age*Realism	0.056	2	0.028	0.781	**n.s.**	
Condition*Realism	0.079	2	0.040	1.114	n.s.	
Age*Cond.*Realism	0.093	4	0.023	0.653	n.s	
Error	18.377	666	0.028			
Look Type (L.T.)	38.019	3	12.673	459.283	<0.001	<0.001
Age*Look Type	0.760	6	0.127	4.588	<0.001	<0.001
Condition*Look Type	0.121	6	0.020	0.729	n.s.	n.s.
Realism*Look Type	0.015	3	0.005	0.182	n.s.	n.s.
Age*Condition*L.T.	0.306	12	0.026	0.925	n.s	n.s
Age*Realism*L.T.	0.118	6	0.020	0.711	n.s.	n.s.
Cond.*Realism*L.T.	0.132	6	0.022	0.795	n.s.	n.s.
Age*Condition* Realism*Look Type	0.449	12	0.037	1.355	n.s	n.s

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The ANOVA showed main effects of age ($F(2,222)=5.72$ $p<.01$) and look type ($F(3,560)=459.28$ $p<.001$*) and an interaction between the two ($F(5,560)=4.59$ $p<.001$*). The 4-year-olds looked less than both the 6- and 8-year-olds (Scheffe ps<.001), and there were significant differences between all look types (Scheffe ps<.05). The interaction revealed that the six-year-olds looked more at the 'beginning' than the four-year-olds and the eight-year-olds looked more 'within' than the four-year-olds (Scheffe ps<.05).

TABLE G.10 **MEAN LOOKING TIME (SECONDS) PER INSTRUCTION, CONDITION AND AGE**

AGE / INSTRUCTION		CONDITION 1 (NON-OCCLUSION)	CONDITION 2 (TOTAL OCCLUSION)	CONDITION 3 (PARTIAL OCCLUSION)	TOTAL MEAN
Four	Standard	0.94	1.07	0.90	
	Explicit	1.41	1.38	1.06	**1.13**
Six	Standard	1.53	2.25	2.23	
	Explicit	3.23	2.73	2.07	**2.34**
Eight	Standard	1.50	1.73	1.93	
	Explicit	2.65	2.50	2.33	**2.21**

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

APPENDIX H

The following tables detail the Log-Linear model selection precedure for the drawing data for Study 4 (Chapter 5). The Likelihood Ratios for Chi-Square Change show how the chi-square statistic for the overall model would change if that particular simple effect was removed from the model. Therefore in a series of steps, the non-significant simple effect with the lowest Likelihood Ratio is removed and the model is recomputed. The final model selected therefore includes only those effects that would make a significant reduction to the statistic if removed.

When an appropriate model is selected the residuals (i.e. the difference between the observed frequencies and the expected frequencies based on the selected model) and the standardised residuals (residuals / square-root of the expected frequencies) are calculated. If the selected model fits the observed data adequately, these residuals should be fairly small. If the standardised residuals are greater than 1.96, or less than -1.96 this would suggest that the final model does not provide an adequate fit or explanation of the observed frequences.

TASK 2

TABLE H.1 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING ORDER AND DRAWING REALISM

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	Order*Realism	2.254	1	n.s.
2	Order, **Realism**	0.051 23.859	1 1	n.s. **<0.001**
3	**Realism**	23.859	1	**<0.001**

* Change in Chi-square statistic if the simple effect is deleted.
† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.
The significant effects are highlighted.

TABLE H.2 OBSERVED, EXPECTED FREQUENCIES AND RESIDUALS BASED ON THE SELECTED MODEL OF DRAWING REALISM

Order	Realism	Observed Frequency	Expected Frequency	Residuals	Standardised Residuals
1/2	Visual	32.00	30.00	+2.000	+0.635
	Intellectual	6.00	9.00	-3.000	-1.000
2/1	Visual	28.00	30.00	-2.000	-0.365
	Intellectual	12.00	9.00	+3.000	+1.000

TABLE H.3 BACKWARD ELIMINATION OF POSSIBLE MODELS INCLUDING EXPOSURE AND DRAWING REALISM

STEP	MODEL †	LIKELIHOOD RATIO FOR X^2 CHANGE *	D.F.	P.
1	**Exposure*Realism**	11.149	1	<0.001

* Change in Chi-square statistic if the simple effect is deleted.

† Each model is made up of simple effects. Each effect is shown on a separate line with the X^2 statistic for its removal along side it, in the next column.

The significant effect is highlighted.

Note: Due to the selection of the saturated model, the expected frequencies were equal to the observed frequencies, and therefore the residuals and standardised residuals were zero.

APPENDIX I

Summary ANOVA tables and details of subsidiary findings for Study 4 (Chapter 5).

TABLE I.1 SUMMARY ANOVA TABLE FOR TOTAL NUMBER OF LOOKS (CONTINUOUS AND SHORT EXPOSURES)

SOURCE	S.S.	D.F.	M.S.	F.	P.
Error	3.231	76	0.043		
Exposure	9.944	1	9.944	233.904	**<0.001**
Task Order	0.013	1	0.013	0.302	**n.s.**
Exposure*Task Order	0.017	1	0.017	0.395	n.s.
Error	0.849	76	0.112		
Drawing Order (D.Order)	0.369	1	0.369	33.047	**<0.001**
Exposure*Drawing Order	0.047	1	0.047	4.243	<0.05
Task Order*Drawing Order	0.214	1	0.214	19.164	<0.001
Exposure*Task Order*D.Order	0.123	1	0.123	11.047	**<0.01**

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

TABLE I.2 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS BY DRAWING REALISM (CONTINUOUS AND SHORT EXPOSURES)

SOURCE	S.S.	D.F.	M.S.	F.	P.
Error	2.350	73	0.032		
Drawing Realism (Task 1)	0.026	1	0.026	0.816	**n.s.**
Exposure	1.140	1	1.140	35.396	<0.001
Exposure*Drawing Realism	0.086	1	0.086	2.661	n.s.
Error	1.715	74	0.023		
Drawing Realism (Task 2)	0.063	1	0.063	2.730	**n.s.**
Exposure	1.715	1	1.715	73.974	<0.001
Exposure*Drawing Realism	0.196	1	0.196	8.464	**<0.01**

n.s. = non-sigificant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

Both tasks showed a highly significant main effects of exposure (ps<.001), in that the continuous exposure led to increased levels of looking.

TABLE I.3 **SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS (CONTINUOUS EXPOSURE)**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	15.787	38	0.415			
Task Order	0.138	1	0.138	0.331	**n.s.**	
Error	11.321	114	0.099			
Look Type	3.999	3	1.333	13.423	**<0.001**	**<0.001**
Task Order*Look Type	2.072	3	0.691	6.956	<0.001	<0.001
Error	4.874	38	0.128			
Drawing Order (D.O.)	13.386	1	13.386	104.361	**<0.001**	
Task Order*Drawing Order	0.527	1	0.527	4.105	0.050	
Error	17.951	114	0.157			
Look Type*Drawing Order	16.662	3	5.554	35.272	<0.001	<0.001
Task Order*Look Type*D.O.	0.656	3	0.219	1.388	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The task order by drawing order interaction was only just significant ($F(1,38)=4.11$ $p=.05$). However Scheffe follow-up analysis revealed that increased looking occurred when Task 2 was presented first (Scheffe $F(1,38)=31.93$ $p<.01$).

Drawing order also interacted with look type ($F(2,71)=35.27$ $p<.001$*) as detailed in Table I.4. Scheffe's follow-up analysis only showed that the 'end' looks were significantly fewer than the other three look types, for both Tasks 1 and 2. Task 1 did however show a higher level of significance (Scheffe $p<.01$ and $p<.05$ respectively).

TABLE I.4 **MEAN NUMBER OF LOOKS PER DRAWING ORDER AND LOOK TYPE**

DRAWING ORDER	N	BEGINNING	BETWEEN	WITHIN	END	MEAN TOTAL
FIRST	40	1.72 (2.02)	1.75 (2.25)	2.14 (4.15)	1.13 (0.33)	**1.69 (2.19)**
SECOND	40	1.59 (1.58)	1.62 (1.75)	1.77 (2.40)	1.08 (0.20)	**1.52 (1.48)**
MEAN TOTAL		**1.65 (1.81)**	**1.69 (2.00)**	**1.96 (3.28)**	**1.11 (0.27)**	

Untransformed means (number of looks) are shown in parentheses.

TABLE I.5 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS BY DRAWING REALISM (CONTINUOUS EXPOSURE)

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	10.155	38	0.267			
Drawing Realism (Task 1)	0.296	1	0.296	1.109	**n.s.**	
Error	13.338	114	0.117			
Look Type	2.417	3	0.806	6.887	<0.001	<0.01
Realism(Task 1)*Look Type	0.230	3	0.100	0.855	n.s.	n.s.
Error	9.227	37	0.249			
Drawing Realism (Task 2)	1.010	1	1.010	4.051	**0.051**	
Error	15.986	111	0.144			
Look Type	3.236	3	1.079	7.490	<0.001	<0.001
Realism(Task 2)*Look Type	2.181	3	0.727	5.047	**<0.01**	**<0.01**

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

Both tasks showed highly significant main effects of look type (ps<.001) where the 'end' looks were lower than the other three look types.

TABLE I.6 SUMMARY ANOVA TABLE FOR TOTAL LOOKING TIME (CONTINUOUS AND SHORT EXPOSURES)

SOURCE	S.S.	D.F.	M.S.	F.	P.
Error	2.778	76	0.037		
Exposure	4.015	1	4.015	109.687	**<0.001**
Task Order	0.002	1	0.002	0.044	**n.s.**
Exposure*Task Order	0.066	1	0.066	1.797	n.s.
Error	0.624	76	0.008		
Drawing Order	0.413	1	0.413	50.303	**<0.001**
Exposure*Drawing Order	0.034	1	0.034	4.109	**<0.05**
Task Order*Drawing Order	0.002	1	0.002	0.293	n.s.
Exposure*Task Order*Drawing Order	0.011	1	0.011	1.310	n.s.

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

TABLE I.7 **SUMMARY ANOVA TABLE FOR LOOKING TIME BY DRAWING REALISM (CONTINUOUS AND SHORT EXPOSURES)**

SOURCE	S.S.	D.F.	M.S.	F.	P.
Error	1.649	73	0.023		
Drawing Realism (Task1)	0.010	1	0.010	0.424	**n.s.**
Exposure	0.625	1	0.625	27.671	<0.001
Exposure*Realism	0.081	1	0.081	3.594	0.062
Error	1.947	74	0.026		
Drawing Realism (Task2)	0.073	1	0.073	2.776	**n.s.**
Exposure	0.514	1	0.514	19.519	<0.001
Exposure*Realism	0.074	1	0.074	2.819	n.s.

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

Both tasks showed a highly significant main effects of exposure (ps<.001), in that the continuous exposure led to increased levels of looking.

TABLE I.8 **SUMMARY ANOVA TABLE FOR LOOKING TIME (CONTINUOUS EXPOSURE)**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	22.917	38	0.603			
Task Order	0.290	1	0.290	0.481	**n.s.**	
Error	13.882	114	0.122			
Look Type	24.838	3	8.279	67.990	**<0.001**	**<0.001**
Task Order*Look Type	1.238	3	0.413	3.389	<0.05	<0.05
Error	8.523	38	0.224			
Drawing Order	52.476	1	52.476	233.977	**<0.001**	
Task Order*Drawing Order	0.430	1	0.430	1.916	n.s.	
Error	28.711	114	0.252			
Look Type*Drawing Order	2.098	3	0.699	2.777	<0.05	n.s.
Task Order*Look Type *Drawing Order	1.247	3	0.416	1.651	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

TABLE I.9 **SUMMARY ANOVA TABLE FOR LOOKING TIME BY DRAWING REALISM (CONTINUOUS EXPOSURE)**

SOURCE	S.S.	D.F.	M.S.	F.	P.	G-G P.†
Error	12.670	38	0.334			
Drawing Realism (Task 1)	0.495	1	0.495	1.483	**n.s.**	
Error	26.149	114	0.229			
Look Type	5.807	3	1.936	8.439	<0.001	<0.001
Realism(Task 1)*Look Type	0.498	3	0.166	0.724	n.s.	n.s.
Error	15.197	37	0.411			
Drawing Realism (Task 2)	1.275	1	1.275	3.105	**0.086**	
Error	20.258	111	0.183			
Look Type	9.132	3	3.044	16.679	<0.001	<0.001
Realism(Task2)*Look Type	1.599	3	0.533	2.920	**<0.05**	**n.s.**

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

Both tasks showed highly significant main effects of look type (ps<.001). For Task 1 the 'beginning' looks were greater than, and the 'end' looks lower than, all other look types (Scheffe ps<.01). For Task 2 each look type was significantly different from each other (Scheffe ps<.001).

APPENDIX J

CATEGORY CLASSIFICATION DETAILS FOR THE LONGITUDINAL STUDY (DRAWING AND MEMORY TASKS)

The following provides examples of the type of responses that the children gave to the various meta-awareness questions for the longitudinal study and the categories that they were subsequently classified into.

META-AWARENESS RESPONSES FOR THE DRAWING TASK

Responses to the question of why they thought they would still be able to draw the models even if they were hidden from view while they were actually drawing.

Extensive Awareness

I saw them and looked at them.

I saw them and concentrated on them.

I noticed them.

Limited Awareness

I know what shape they are.

I've seen them before.

I can remember how to draw them.

It's easy.

I'm clever.

The balls are round.

No Awareness

I can just copy my first drawing.

It was a ball/cup.

Dont Know.

Because it is there.

I can't draw it as I have a bad arm.

Because I'm five.

META-AWARENESS RESPONSES FOR THE MEMORY TASK

Responses to why they thought the arrangement of cards they had chosen would help them to remember the cards.

Extensive Awareness

They are all in groups.

They are all sorted out.

I can say all the animals, then all the food, then all the house things.

Limited Awareness

You can remember them more.

It's easy.

I've been doing it in class.

Because I know/like them.

Because they are all mixed up.

> (This latter response refers to children who initially selected the mixed arrangement. Although incorrect, it does show some awareness of how the arrangement of the cards can affect recall performance).

No Awareness

There are more cards here (pointing to the mixed arrangement).

This is a horse, this a butterfly, this a chair etc. etc..

Dont know.

I can get to see all the pictures.

Because I eat lions.

APPENDIX K

ILLUSTRATION OF THE WINDOW OPENING STRATEGIES FOR THE LONGITUDINAL STUDY (SELECTIVE ATTENTION TASK)

The following details the order with which the children opened the twelve windows in each house pair in order to be classified into a particular window opening strategy.

EXHAUSTIVELY STRATEGIC

1: Opening homologous pairs

1	3
5	7
9	11

2	4
6	8
10	12

2: Systematically opening all the windows in one house, then all the windows in the other. (To be classified as an exhaustive strategy this had to be accompanied by scanning back to the first house while opening the windows in the second).

1	4
2	5
3	6

7	10
8	11
9	12

3: Opening systematically across pairs in horizontal rows (accompanied by scanning back).

1	2
5	6
9	10

3	4
7	8
11	12

4: Opening systematically across pairs in vertical columns i.e. opening homologous columns (accompanied by scanning back).

1	7
2	8
3	9

4	10
5	11
6	12

LIMITED STRATEGIC

1: Strategies 2, 3 and 4 above without being accompanied by scanning.

2: Random searching within each house separately.

1	6
5	2
4	3

11	12
9	8
10	7

NON-STRATEGIC

1: Opening windows in just one house.

1	4
2	5
3	6

2: Random opening across both houses.

1	7
12	3
4	9

6	2
10	8
11	5

3: Opening non-homologous columns.

1	7
2	8
3	9

10	4
11	5
12	6

APPENDIX L

Summary ANOVA tables and details of subsidiary findings for the Longitudinal study, Phase 1 (Chapter 8).

DRAWING TASK

TABLE L.1 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	48	0.626	0.013			
Age	2	0.056	0.028	2.149	**n.s.**	
Sex	1	0.121	0.121	9.279	**<0.01**	
Drawing Order (D.Order)	1	0.050	0.050	3.870	n.s.	
Age*Sex	2	0.088	0.044	3.382	<0.05	
Age*Drawing Order	2	0.121	0.061	4.643	<0.05	
Sex*Drawing Order	1	0.008	0.008	0.641	n.s	
Age*Sex*Drawing Order	2	0.026	0.013	0.991	n.s	
Error	48	0.574	0.012			
Drawing Model	1	0.034	0.034	2.851	**n.s.**	
Age*Model	2	0.064	0.032	2.685	n.s.	
Sex*Model	1	0.004	0.004	0.355	n.s.	
Drawing Order*Model	1	0.156	0.156	13.043	**<0.01**	
Age*Sex*Model	2	0.018	0.009	0.748	n.s.	
Age*Drawing Order*Model	2	0.001	0.000	0.033	n.s.	
Sex*Drawing Order*Model	1	0.011	0.011	0.916	n.s.	
Age*Sex*D.Order*Model	2	0.034	0.017	1.400	n.s.	
Error	144	2.400	0.017			
Look Type	3	10.924	3.621	232.546	**<0.001**	**<0.001**
Age*Look Type	6	0.109	0.018	1.087	n.s.	n.s.
Sex*Look Type	3	0.073	0.024	1.469	n.s.	n.s.
Drawing Order*Look Type	3	0.028	0.009	0.566	n.s.	n.s.
Age*Sex*Look Type	6	0.146	0.024	1.461	n.s.	n.s.
Age*D.Order*Look Type	6	0.079	0.013	0.788	n.s.	n.s.
Sex*D.Order*Look Type	3	0.004	0.001	0.089	n.s.	n.s.
Age*Sex*D.Order*Look Type	6	0.170	0.028	1.702	n.s.	n.s.
Error	144	1.751	0.012			
Model*Look Type	3	0.081	0.027	2.217	n.s.	n.s.
Age*Model*Look Type	6	0.102	0.017	1.396	n.s.	n.s.
Sex*Model*Look Type	3	0.019	0.006	0.515	n.s.	n.s.
D.Order.*Model*Look Type	3	0.120	0.040	3.298	<0.05	<0.05
Age*Sex*Model*Look Type	6	0.077	0.013	1.051	n.s.	n.s.
Age*D.Order*Model*Look Type	6	0.026	0.004	0.351	n.s.	n.s.
Sex*D.Order*Model*Look Type	3	0.031	0.010	0.852	n.s.	n.s.
Age*Sex*Drawing Order* Model*Look Type	6	0.068	0.011	0.938	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The ANOVA showed a significant main effect of gender ($F(1,48)=9.28$ $p<.01$) in that the females looked at the model more than the males (mean number of looks = 0.62 and 0.47 respectively). Although the ANOVA showed no main effect of age ($F(2,48)=2.15$ $p>.05$), this factor did significantly interact with drawing order ($F(2,48)=4.64$ $p<.05$) and with gender ($F(2,48)=3.38$ $p<.05$). However Scheffe follow-up analysis showed no significant differences between any of the individual means (ps>.05). Look type significantly interacted with the drawing model and drawing order ($F(3,126)=3.30$ $p<.05$*), however follow-up analysis only revealed that the 'beginning' looks were greater than all other look types, for each order and model combination (Scheffe ps<.01).

TABLE L.2 **SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS BY DRAWING REALISM**

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	50	0.820	0.016			
Cup Realism	1	0.061	0.061	3.747	**0.059**	
Age	2	0.143	0.072	4.374	<0.05	
Cup Realism*Age	2	0.104	0.052	3.174	n.s.	
Error	150	2.815	0.019			
Look Type	3	4.543	1.514	80.692	<0.001	<0.001
Cup Realism*Look Type	3	0.223	0.074	3.964	**<0.01**	**<0.05**
Age*Look Type	6	0.069	0.011	0.610	n.s.	n.s.
Cup Realism*Age*Look Type	6	0.128	0.021	1.138	n.s.	n.s.
Error	46	0.581	0.013			
Ball Realism	1	0.034	0.034	2.655	**n.s.**	
Age	2	0.006	0.003	0.256	n.s.	
Ball Realism*Age	2	0.017	0.008	0.672	n.s.	
Error	138	1.274	0.009			
Look Type	3	1.577	0.523	56.597	<0.001	<0.001
Ball Realism*Look Type	3	0.027	0.009	0.977	**n.s.**	**n.s.**
Age*Look Type	6	0.134	0.022	2.422	<0.05	<0.05
Ball Realism*Age*Look Type	6	0.064	0.011	1.164	n.s.	n.s.

† Epsilon correct (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

For the ball task there was a significant main effect of look type ($F(3,122)=56.60$ $p<.001$*) and an interaction between age and look type ($F(5,122)=2.42$ $p<.05$*) where the 'beginning' looks were greater than all other look types, for all ages.

*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probabilitiy values.

TABLE L.3 SUMMARY ANOVA TABLE FOR LOOKING TIME

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	48	0.864	0.018			
Age	2	0.035	0.018	0.982	**n.s.**	
Sex	1	0.097	0.097	5.365	**<0.05**	
Drawing Order (D.Order)	1	0.019	0.019	1.081	n.s.	
Age*Sex	2	0.010	0.005	0.265	n.s.	
Age*Drawing Order	2	0.089	0.044	2.460	n.s.	
Sex*Drawing Order	1	0.002	0.002	0.092	n.s.	
Age*Sex*Drawing Order	2	0.048	0.024	1.325	n.s.	
Error	48	0.424	0.009			
Drawing Model	1	0.007	0.007	0.776	**n.s.**	
Age*Model	2	0.168	0.084	9.497	**<0.001**	
Sex*Model	1	0.011	0.011	1.262	n.s.	
Drawing Order*Model	1	0.182	0.182	20.548	**<0.001**	
Age*Sex*Model	2	0.026	0.013	1.480	n.s.	
Age*Drawing Order*Model	2	0.005	0.003	0.298	n.s.	
Sex*Drawing Order*Model	1	0.001	0.001	0.103	n.s.	
Age*Sex*D.Order*Model	2	0.030	0.015	1.714	n.s.	
Error	144	2.536	0.018			
Look Type	3	23.950	7.983	453.309	**<0.001**	**<0.001**
Age*Look Type	6	0.069	0.012	0.657	n.s.	>0.05
Sex*Look Type	3	0.074	0.025	1.394	n.s.	>0.05
D.O.*Look Type	3	0.043	0.014	0.804	n.s.	>0.05
Age*Sex*Look Type	6	0.165	0.028	1.562	n.s.	>0.05
Age*D.O.*Look Type	6	0.059	0.010	0.562	n.s.	>0.05
Sex*D.O.*Look Type	3	0.069	0.023	1.310	n.s.	>0.05
Age*Sex*D.Order*Look Type	6	0.210	0.035	1.983	n.s.	>0.05
Error	144	1.492	0.010			
Model*Look Type	3	0.103	0.034	3.310	<0.05	>0.05
Age*Model*Look Type	6	0.035	0.006	0.563	n.s.	>0.05
Sex*Model*Look Type	3	0.017	0.006	0.563	n.s.	>0.05
D.Order*Model*Look Type	3	0.214	0.071	6.883	<0.001	<0.001
Age*Sex*Model*Look Type	6	0.098	0.016	1.581	n.s.	>0.05
Age*D.Order*Model*Look Type	6	0.021	0.003	0.335	n.s.	>0.05
Sex*D.Order*Model*Look Type	3	0.018	0.006	0.581	n.s.	>0.05
Age*Sex*Drawing Order* Model*Look Type	6	0.055	0.009	0.879	n.s.	>0.05

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

This ANOVA showed a significant main effect of gender ($F(1,48)=5.36$ $p<.05$) in that the females looked at the model more than the males (mean seconds = 0.91 and 0.75 respectively). Look type significantly interacted with the drawing model ($F(3,122)=3.31$ $p<.05$*) and with both the model and drawing order ($F(3,122)=6.88$ $p<.001$*). For both of these interactions, only the 'beginning' looks were found to be significantly higher than all other look types, across all levels of the other factors (Scheffe ps<.001).

*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probabilitiy values.

TABLE L.4 SUMMARY ANOVA TABLE FOR LOOKING TIME BY DRAWING REALISM

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	50	0.775	0.015			
Cup Realism	1	0.129	0.129	8.338	**<0.01**	
Age	2	0.232	0.116	7.479	<0.01	
Cup Realism*Age	2	0.044	0.022	1.404	n.s.	
Error	150	2.978	0.020			
Look Type	3	8.719	2.906	146.419	<0.001	<0.001
Cup Realism*Look Type	3	0.167	0.056	2.819	**<0.05**	**n.s.**
Age*Look Type	6	0.083	0.014	0.693	n.s.	n.s.
Cup Realism*Age*Look Type	6	0.131	0.022	1.102	n.s.	n.s.
Error	46	0.503	0.011			
Ball Realism	1	0.073	0.073	6.684	**<0.05**	
Age	2	0.019	0.009	0.853	n.s.	
Ball Realism*Age	2	0.019	0.010	0.873	n.s.	
Error	138	1.110	0.008			
Look Type	3	4.000	1.333	165.689	<0.001	<0.001
Ball Realism*Look Type	3	0.059	0.020	2.425	**n.s.**	**n.s.**
Age*Look Type	6	0.100	0.017	2.063	n.s.	n.s.
Ball Realism*Age*Look Type	6	0.066	0.011	1.366	n.s.	n.s.

† Epsilon correct (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

For the cup drawing there was a signficant main effect of age ($F(2,50)=7.48$ $p<.01$), in that the five-year-olds looked at the model more than both the four- and six-year-olds (Scheffe ps<.05) (mean seconds = 1.21, 0.68 and 0.86 respectively). This was therefore different from the main analysis, however again this ANOVA could not be performed on the whole sample size.

For the ball drawing, the ANOVA showed a highly significant main effect of look type ($F(2,108)=165.69$ $p<.001$*). Follow-up analysis revealed that, like the main analysis, that the 'beginning' looks were greater than all other look types (ps<.001).

*Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probabilitiy values.

MEMORY TASK

TABLE L.5 SUMMARY ANOVA TABLE FOR MEMORY RECALL SCORES

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	48	1.924	0.040		
Age	2	2.915	1.457	36.349	**<0.001**
Sex	1	0.023	0.023	0.566	n.s.
Presentation Order (Order)	1	0.062	0.062	1.556	n.s.
Age*Sex	2	0.407	0.204	5.079	<0.05
Age*Order	2	0.143	0.071	1.781	n.s.
Sex*Order	1	0.112	0.112	2.805	n.s.
Age*Sex*Order	2	0.256	0.128	3.187	n.s.
Error	48	0.825	0.017		
Display Type	1	0.550	0.550	32.019	**<0.001**
Age*Display Type	2	0.293	0.146	8.520	**<0.01**
Sex*Display Type	1	0.017	0.017	0.975	n.s.
Order*Display Type	1	0.333	0.333	19.388	**<0.001**
Age*Sex*Display Type	2	0.022	0.011	0.654	n.s.
Age*Order*Display Type	2	0.120	0.060	3.504	**<0.05**
Sex*Order*Display Type	1	0.000	0.000	0.003	n.s.
Age*Sex*Order*Display Type	2	0.061	0.030	1.772	n.s.

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

Although there was no main effect of gender (F(1,48)=0.57 p>.05) this factor did significantly interact with age (F(2,48)=5.08 p<.05). Follow-up analysis revealed that while the six-year-old males were significantly different from both the four- and five-year-old males (Scheffe ps<.05), the five- and six-year-old females were significantly different from both the four-year-old females (Scheffe ps<.05). These means are detailed in Table L.6.

TABLE L.6 MEAN RECALL SCORES PER AGE AND GENDER

AGE	N	MALES	FEMALES	MEAN TOTAL
4 YEARS	20	0.35 (4.05)	0.21 (2.50)	**0.28 (3.28)**
5 YEARS	20	0.37 (4.24)	0.50 (5.62)	**0.43 (4.93)**
6 YEARS	20	0.62 (6.84)	0.71 (7.51)	**0.66 (7.18)**
MEAN TOTAL		**0.45 (5.04)**	**0.47 (5.21)**	

Untransformed means (number of cards recalled) are shown in parentheses.

TABLE L.7 **SUMMARY ANOVA TABLE FOR ARC CLUSTERING SCORES**

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	33	41.049	1.244		
Age	2	1.014	0.507	0.408	n.s.
Presentation Order (Order)	1	2.512	2.512	2.019	n.s.
Age*Order	2	8.199	4.100	3.296	n.s.
Error	33	21.208	0.643		
Display Type	1	6.945	6.945	10.807	**<0.01**
Age*Display Type	2	1.487	0.744	1.157	n.s.
Order*Display Type	1	0.064	0.064	0.100	n.s.
Age*Order*Display Type	2	0.335	0.167	0.260	n.s.

n.s. = non-significant effect at p>0.05.
The main finding is highlighted.

TABLE L.8 **SUMMARY ANOVA TABLE FOR RECALL SCORES BY CLUSTERING CATEGORIES**

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	35	0.551	0.016		
Age	2	0.091	0.046	2.901	n.s.
Clustering - Mixed	2	0.100	0.050	3.165	**n.s.**
Age*Clustering	4	0.068	0.017	1.083	n.s.
Error	37	1.333	0.036		
Age	2	0.373	0.187	5.183	<0.05
Clustering - Grouped	2	0.089	0.045	1.240	**n.s.**
Age*Clustering	4	0.072	0.018	0.498	n.s.

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

There was a significant main effect of age for the grouped display type ($F(2,37)=5.18$ $p<0.05$), in that the six-year-olds showed higher levels of recall than the younger two age groups (ps<.001).

SELECTIVE ATTENTION TASK

TABLE L.9 **SUMMARY ANOVA TABLE FOR TOTAL NUMBER OF ACCURATE JUDGEMENTS**

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	58	11.896	0.205		
Practice Order	1	0.000	0.000	0.000	n.s.
Error	48	7.855	0.164		
Experimental Order	3	0.218	0.073	0.445	n.s.
Age	2	3.321	1.660	10.147	**<0.001**
Age*Experimental Order	6	0.502	0.084	0.511	n.s.

n.s. = non-significant effect at p>0.05.
The main finding is highlighted.

APPENDIX M

Summary ANOVA tables and details of subsidiary findings for the Longitudinal Study, Phase 2 (Chapter 9).

DRAWING TASK

TABLE M.1 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	35	0.777	0.022			
Age	2	0.379	0.190	8.550	**<0.01**	
Sex	1	0.010	0.010	0.464	n.s.	
Drawing Order (D.Order)	1	0.006	0.006	0.278	n.s.	
Age*Sex	2	0.061	0.030	1.365	n.s.	
Age*Drawing Order	2	0.151	0.076	3.405	**<0.05**	
Sex*Drawing Order	1	0.000	0.000	0.004	n.s.	
Age*Sex*Drawing Order	2	0.116	0.058	2.617	n.s.	
Error	35	0.279	0.008			
Drawing Model	1	0.004	0.004	0.499	**n.s.**	
Age*Model	2	0.064	0.032	4.042	**<0.05**	
Sex*Model	1	0.003	0.003	0.349	n.s.	
Drawing Order*Model	1	0.000	0.000	0.043	n.s.	
Age*Sex*Model	2	0.007	0.004	0.447	n.s.	
Age*Drawing Order*Model	2	0.004	0.002	0.229	n.s.	
Sex*Drawing Order*Model	1	0.001	0.001	0.124	n.s.	
Age*Sex*D.Order*Model	2	0.016	0.008	0.998	n.s.	
Error	105	1.303	0.012			
Look Type	3	8.015	2.672	215.349	**<0.001**	**<0.001**
Age*Look Type	6	0.355	0.059	4.772	**<0.001**	**<0.001**
Sex*Look Type	3	0.049	0.016	1.307	n.s.	n.s.
D.Order*Look Type	3	0.073	0.024	1.969	n.s.	n.s.
Age*Sex*Look Type	6	0.090	0.015	1.215	n.s.	n.s.
Age*D.Order*Look Type	6	0.255	0.042	3.423	**<0.01**	**<0.01**
Sex*D.Order*Look Type	3	0.091	0.030	2.458	n.s.	n.s.
Age*Sex*D.Order*Look Type	6	0.083	0.014	1.113	n.s.	n.s.
Error	105	0.964	0.009			
Model*Look Type	3	0.191	0.064	6.935	<0.001	<0.001
Age*Model*Look Type	6	0.335	0.056	6.080	**<0.001**	**<0.001**
Sex*Model*Look Type	3	0.040	0.013	1.444	n.s.	n.s.
D.Order.*Model*Look Type	3	0.026	0.009	0.952	n.s.	n.s.
Age*Sex*Model*Look Type	6	0.072	0.012	1.298	n.s.	n.s.
Age*D.Order*Model*Look Type	6	0.112	0.019	2.033	n.s.	n.s.
Sex*D.Order*Model*Look Type	3	0.035	0.012	1.285	n.s.	n.s.
Age*Sex*Drawing Order* Model*Look Type	6	0.072	0.012	0.314	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at $p>0.05$.
The main findings are highlighted.

TABLE M.2 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS BY DRAWING REALISM

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	41	0.541	0.013			
Cup Realism	1	0.157	0.157	11.890	**<0.01**	
Age	2	0.202	0.101	7.647	<0.01	
Cup Realism*Age	2	0.144	0.072	5.443	**<0.01**	
Error	123	1.426	0.012			
Look Type	3	1.635	0.545	47.002	<0.001	<0.001
Cup Realism*Look Type	3	0.141	0.047	4.048	**<0.01**	**<0.05**
Age *Look Type	6	0.351	0.059	5.053	<0.001	<0.001
Cup Realism*Age*Look Type	6	0.097	0.016	1.391	n.s.	n.s.
Error	40	0.529	0.013			
Ball Realism	1	0.007	0.007	0.530	**n.s.**	
Age	2	0.137	0.068	5.169	<0.05	
Ball Realism*Age	2	0.035	0.017	1.314	n.s.	
Error	120	1.230	0.010			
Look Type	3	1.995	0.665	64.865	<0.001	<0.001
Ball Realism*Look Type	3	0.090	0.030	2.940	**<0.05**	**<0.05**
Age *Look Type	6	0.074	0.012	1.202	n.s.	n.s.
Ball Realism*Age*Look Type	6	0.061	0.010	0.998	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

For the cup model, the ANOVA showed a significant main effect of look type ($F(3,95)= 47.11$ $p<.001$*) and an interaction between look type and age ($F(5,95)=5.05$ $p<.001$*). Follow-up analysis revealed that the 'beginning' looks were greater than all other look types (Scheffe ps<.001) and the 'within' looks were greater than the 'between' and 'end' looks (Scheffe ps<.05). However it was only the seven-year-olds who showed a high incidence of 'within' looking.

For the ball model, there was a significant main effect of age ($F(2,40)=5.17$ $p<.05$). Follow-up analysis revealed that the five-year-olds looked less than the four- and seven-year-olds (mean number of looks = 0.33, 0.61 and 0.65 respectively). However the four-year-old mean was inflated by having only one visually realistic child in this age group who paid higher than average attention to the model. The ANOVA also showed a significant main effect of look type ($F(3,113)=64.86$ $p<.001$*), in that the 'beginning' looks were greater than all other look types (Scheffe ps<.001).

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE M.3 SUMMARY ANOVA TABLE FOR LOOKING TIME

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	35	1.083	0.031			
Age	2	0.664	0.332	10.719	**<0.001**	
Sex	1	0.002	0.002	0.078	n.s.	
Drawing Order (D.Order)	1	0.011	0.011	3.342	n.s.	
Age*Sex	2	0.005	0.003	0.848	n.s.	
Age*Drawing Order	2	0.082	0.041	1.327	n.s.	
Sex*Drawing Order	1	0.001	0.001	0.021	n.s.	
Age*Sex*Drawing Order	2	0.056	0.028	0.901	n.s.	
Error	35	0.359	0.010			
Drawing Model	1	0.005	0.005	0.522	**n.s.**	
Age*Model	2	0.024	0.012	1.184	n.s.	
Sex*Model	1	0.008	0.008	0.796	n.s.	
Drawing Order*Model	1	0.000	0.000	0.031	n.s.	
Age*Sex*Model	2	0.065	0.032	3.157	n.s.	
Age*Drawing Order*Model	2	0.008	0.004	0.408	n.s.	
Sex*Drawing Order*Model	1	0.001	0.001	0.070	n.s.	
Age*Sex*D.Order*Model	2	0.008	0.004	0.384	n.s.	
Error	105	1.809	0.017			
Look Type	3	20.167	6.722	390.271	**<0.001**	**<0.001**
Age*Look Type	6	0.205	0.034	1.980	n.s.	n.s.
Sex*Look Type	3	0.045	0.015	0.867	n.s.	n.s.
D.Order*Look Type	3	0.084	0.028	1.632	n.s.	n.s.
Age*Sex*Look Type	6	0.081	0.013	0.779	n.s.	n.s.
Age*D.Order*Look Type	6	0.187	0.031	1.814	n.s.	n.s.
Sex*D.Order*Look Type	3	0.089	0.030	1.726	n.s.	n.s.
Age*Sex*D.Order*Look Type	6	0.045	0.008	0.437	n.s.	n.s.
Error	105	1.314	0.013			
Model*Look Type	3	0.341	0.114	9.092	**<0.001**	**<0.001**
Age*Model*Look Type	6	0.296	0.049	3.937	**<0.01**	**<0.01**
Sex*Model*Look Type	3	0.028	0.009	0.732	n.s.	n.s.
D.Order.*Model*Look Type	3	0.015	0.005	0.415	n.s.	n.s.
Age*Sex*Model*Look Type	6	0.154	0.026	2.058	n.s.	n.s.
Age*D.Order*Model*Look Type	6	0.058	0.009	0.779	n.s.	n.s.
Sex*D.Order*Model*Look Type	3	0.058	0.019	1.537	n.s.	n.s.
Age*Sex*Drawing Order* Model*Look Type	6	0.088	0.147	1.177	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

TABLE M.4 SUMMARY ANOVA TABLE FOR LOOKING TIME BY DRAWING REALISM

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	41	0.568	0.014			
Cup Realism	1	0.220	0.220	15.888	**<0.001**	
Age	2	0.188	0.094	6.804	<0.01	
Cup Realism*Age	2	0.201	0.100	7.249	**<0.01**	
Error	123	2.158	0.018			
Look Type	3	4.248	1.416	80.706	<0.001	<0.001
Cup Realism*Look Type	3	0.095	0.032	1.798	**n.s.**	**n.s.**
Age *Look Type	6	0.218	0.036	2.068	n.s.	n.s.
Cup Realism*Age*Look Type	6	0.176	0.029	1.668	n.s.	n.s.
Error	40	0.582	0.015			
Ball Realism	1	0.054	0.054	3.690	n.s.	
Age	2	0.110	0.050	3.449	**<0.05**	
Ball Realism*Age	2	0.029	0.014	0.992	n.s.	
Error	120	1.350	0.011			
Look Type	3	5.521	1.840	163.568	<0.001	<0.001
Ball Realism*Look Type	3	0.042	0.014	1.242	**n.s.**	**n.s.**
Age *Look Type	6	0.050	0.008	0.746	n.s.	n.s.
Ball Realism*Age*Look Type	6	0.058	0.010	0.866	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The ANOVA for the cup model showed a significant main effect of look type ($F(2,90)=80.71$ $p<.001$*) where the 'beginning' looks were greater than all other look types, however unlike the main analysis the 'within' looks were also greater than the 'between' looks (Scheffe $F(2,90)=16.20$ $p<.01$).

The ANOVA for the ball model showed a significant main effect of age ($F(2,40)=3.45$ $p<.05$), in that the seven-year-olds looked more than the five- and four-year-olds (mean seconds 1.28, 0.93 and 0.78 respectively). The ANOVA also showed a main effect of look type ($F(2,83)=163.57$ $p<.001$*) where the 'beginning' looks were greater than all other look types (Scheffe ps<.001).

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

MEMORY TASK

TABLE M.5 ANOVA SUMMARY TABLE FOR MEMORY RECALL SCORES

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	35	2.061	0.059		
Age	2	2.139	1.069	18.159	**<0.001**
Sex	1	0.000	0.000	0.000	n.s.
Presentation Order (Order)	1	0.163	0.163	2.772	n.s.
Age*Sex	2	0.334	0.167	2.832	n.s.
Age*Order	2	0.242	0.121	2.054	n.s.
Sex*Order	1	0.179	0.179	3.032	n.s.
Age*Sex*Order	2	0.065	0.033	0.553	n.s.
Error	35	2.001	0.057		
Display Type	1	0.683	0.683	11.956	**<0.001**
Age*Display Type	2	0.488	0.244	4.270	**<0.05**
Sex*Display Type	1	0.000	0.000	0.008	n.s.
Order*Display Type	1	0.045	0.045	0.789	n.s.
Age*Sex*Display Type	2	0.158	0.079	1.380	n.s.
Age*Order*Display Type	2	0.113	0.056	0.985	n.s.
Sex*Order*Display Type	1	0.047	0.047	0.819	n.s.
Age*Sex*Order*Display Type	2	0.018	0.009	0.156	n.s.

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

TABLE M.6 SUMMARY ANOVA TABLE FOR ARC CLUSTERING SCORES

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	27	23.352	0.865		
Age	2	1.181	0.590	0.683	n.s.
Presentation Order (Order)	1	0.034	0.034	0.040	n.s.
Age*Order	2	0.301	0.150	0.174	n.s.
Error	27	20.223	0.749		
Display Type	1	6.394	6.394	8.537	**<0.01**
Age*Display Type	2	4.542	2.271	3.032	n.s.
Order*Display Type	1	1.366	1.366	1.824	n.s.
Age*Order*Display Type	2	0.145	0.073	0.097	n.s.

n.s. = non-significant effect at p>0.05.
The main finding is highlighted.

TABLE M.7 **SUMMARY ANOVA TABLE FOR RECALL SCORES BY CLUSTERING CATEGORIES**

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	27	0.482	0.018		
Age	2	0.038	0.019	1.055	n.s.
Clustering - Mixed	2	0.058	0.029	1.628	**n.s.**
Age*Clustering	4	0.091	0.023	1.277	n.s.
Error	36	3.986	0.111		
Clustering - Grouped	2	0.205	0.102	0.925	**n.s.**

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

SELECTIVE ATTENTION TASK

TABLE M.8 **ANOVA SUMMARY TABLE FOR TOTAL NUMBER OF ACCURATE JUDGEMENTS**

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	45	12.181	0.271		
Practice Order	1	0.200	0.200	0.738	n.s.
Error	35	5.645	0.161		
Experimental Order	3	0.611	0.204	1.262	n.s.
Age	2	4.611	2.305	14.293	**<0.001**
Age*Experimental Order	6	1.188	0.198	1.228	n.s.

n.s.= non-significant effect at p>0.05.
The main finding is highlighted.

APPENDIX N

Summary ANOVA tables and details of subsidiary findings for the Longitudinal Study, Phase 3 (Chapter 10).

DRAWING TASK

TABLE N.1 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	31	0.966	0.031			
Age	2	0.140	0.070	2.249	**n.s.**	
Sex	1	0.009	0.009	0.294	n.s.	
Drawing Order (D.Order)	1	0.015	0.015	0.482	**n.s.**	
Age*Sex	2	0.032	0.016	0.510	n.s.	
Age*Drawing Order	2	0.081	0.040	1.298	n.s.	
Sex*Drawing Order	1	0.000	0.000	0.004	n.s.	
Age*Sex*Drawing Order	2	0.002	0.001	0.025	n.s.	
Error	31	0.401	0.013			
Drawing Model	1	0.030	0.030	2.329	**n.s.**	
Age*Model	2	0.050	0.025	1.922	n.s.	
Sex*Model	1	0.014	0.014	1.111	n.s.	
Drawing Order*Model	1	0.113	0.113	8.698	**<0.01**	
Age*Sex*Model	2	0.045	0.023	1.747	n.s.	
Age*Drawing Order*Model	2	0.062	0.031	2.396	n.s.	
Sex*Drawing Order*Model	1	0.003	0.003	0.199	n.s.	
Age*Sex*D.Order*Model	2	0.002	0.001	0.076	n.s.	
Error	93	2.091	0.022			
Look Type	3	5.698	1.899	84.472	**<0.001**	**<0.001**
Age*Look Type	6	0.178	0.030	1.322	n.s.	n.s.
Sex*Look Type	3	0.040	0.013	0.595	n.s.	n.s.
D.Order*Look Type	3	0.029	0.010	0.433	n.s.	n.s.
Age*Sex*Look Type	6	0.048	0.008	0.357	n.s.	n.s.
Age*D.Order*Look Type	6	0.100	0.017	0.742	n.s.	n.s.
Sex*D.Order*Look Type	3	0.070	0.023	1.031	n.s.	n.s.
Age*Sex*D.Order*Look Type	6	0.184	0.031	1.364	n.s.	n.s.
Error	93	1.826	0.020			
Model*Look Type	3	0.160	0.053	2.711	n.s.	n.s.
Age*Model*Look Type	6	0.229	0.038	1.941	n.s.	n.s.
Sex*Model*Look Type	3	0.003	0.001	0.051	n.s.	n.s.
D.Order*Model*Look Type	3	0.216	0.072	3.668	**<0.05**	**<0.05**
Age*Sex*Model*Look Type	6	0.057	0.009	0.480	n.s.	n.s.
Age*D.Order*Model*Look Type	6	0.103	0.017	0.870	n.s.	n.s.
Sex*D.Order*Model*Look Type	3	0.053	0.018	0.898	n.s.	n.s.
Age*Sex*Drawing Order* Model*Look Type	6	0.037	0.006	0.314	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

TABLE N.2 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS BY DRAWING REALISM

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	36	0.872	0.024			
Cup Realism	1	0.026	0.026	1.092	**n.s.**	
Age	2	0.058	0.029	1.192	n.s.	
Cup Realism*Age	2	0.059	0.029	1.214	n.s.	
Error	108	2.596	0.024			
Look Type	3	1.249	0.416	17.321	<0.001	<0.001
Cup Realism*Look Type	3	0.084	0.028	1.164	**n.s.**	**n.s.**
Age *Look Type	6	0.162	0.027	1.124	n.s.	n.s.
Cup Realism*Age*Look Type	6	0.230	0.038	1.598	n.s.	n.s.
Error	41	0.732	0.018			
Ball Realism	1	0.055	0.055	3.102	**n.s.**	
Error	123	1.983	0.016			
Look Type	3	2.450	0.817	50.653	<0.001	<0.001
Ball Realism*Look Type	3	0.031	0.010	0.642	**n.s.**	**n.s.**

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

For both the cup and ball models, the ANOVAs showed significant main effects of look type ($F(2,79)=17.32$ and $F(2,99)=50.65$ ps<.001 respectively*). Follow-up analysis revealed that the 'beginning' looks were greater than all other look types (Scheffe ps<.001).

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE N.3 SUMMARY ANOVA TABLE FOR LOOKING TIME

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	31	0.711	0.023			
Age	2	0.209	0.104	4.552	**<0.05**	
Sex	1	0.000	0.000	0.004	n.s.	
Drawing Order (D.Order)	1	0.038	0.038	1.673	**n.s.**	
Age*Sex	2	0.083	0.041	1.803	n.s.	
Age*Drawing Order	2	0.045	0.023	0.982	n.s.	
Sex*Drawing Order	1	0.000	0.000	0.000	n.s.	
Age*Sex*Drawing Order	2	0.005	0.003	0.113	n.s.	
Error	31	0.561	0.018			
Drawing Model	1	0.027	0.027	1.480	**n.s.**	
Age*Model	2	0.032	0.016	0.880	n.s.	
Sex*Model	1	0.005	0.005	0.279	n.s.	
Drawing Order*Model	1	0.115	0.115	6.341	**<0.05**	
Age*Sex*Model	2	0.061	0.030	1.676	n.s.	
Age*Drawing Order*Model	2	0.083	0.042	2.303	n.s.	
Sex*Drawing Order*Model	1	0.002	0.002	0.097	n.s.	
Age*Sex*D.Order*Model	2	0.002	0.001	0.053	n.s.	
Error	93	1.750	0.019			
Look Type	3	12.408	4.136	219.778	**<0.001**	**<0.001**
Age*Look Type	6	0.186	0.031	1.651	n.s.	n.s.
Sex*Look Type	3	0.058	0.019	1.027	n.s.	n.s.
D.Order*Look Type	3	0.034	0.011	0.598	n.s.	n.s.
Age*Sex*Look Type	6	0.075	0.013	0.665	n.s.	n.s.
Age*D.Order*Look Type	6	0.154	0.026	1.364	n.s.	n.s.
Sex*D.Order*Look Type	3	0.045	0.015	0.797	n.s.	n.s.
Age*Sex*D.Order*Look Type	6	0.124	0.021	1.100	n.s.	n.s.
Error	93	1.450	0.016			
Model*Look Type	3	0.218	0.073	4.655	**<0.01**	**<0.01**
Age*Model*Look Type	6	0.194	0.032	2.075	n.s.	n.s.
Sex*Model*Look Type	3	0.001	0.000	0.019	n.s.	n.s.
D.Order*Model*Look Type	3	0.255	0.085	5.449	**<0.01**	**<0.01**
Age*Sex*Model*Look Type	6	0.053	0.009	0.562	n.s.	n.s.
Age*D.Order*Model*Look Type	6	0.066	0.011	0.702	n.s.	n.s.
Sex*D.Order*Model*Look Type	3	0.009	0.003	0.192	n.s.	n.s.
Age*Sex*Drawing Order* Model*Look Type	6	0.036	0.006	0.385	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The ANOVA also showed a significant interaction between look type, drawing model and drawing order ($F(3,87)=5.45$ $p<.01$*), however follow-up analysis only revealed that the 'beginning' looks were greater than all other look types for all combinations of the other two factors.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

TABLE N.4 SUMMARY ANOVA TABLE FOR LOOKING TIME BY DRAWING REALISM

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P. †
Error	36	0.894	0.025			
Cup Realism	1	0.146	0.146	5.878	**<0.05**	
Age	2	0.040	0.020	0.796	n.s.	
Cup Realism*Age	2	0.059	0.029	1.179	n.s.	
Error	108	2.223	0.021			
Look Type	3	2.600	0.867	42.111	<0.001	<0.001
Cup Realism*Look Type	3	0.193	0.064	3.129	**<0.05**	**<0.05**
Age *Look Type	6	0.259	0.043	2.101	n.s.	n.s.
Cup Realism*Age*Look Type	6	0.278	0.046	2.250	<0.05	n.s.
Error	41	0.412	0.010			
Ball Realism	1	0.117	0.117	11.636	**<0.01**	
Error	123	1.311	0.011			
Look Type	3	6.188	2.063	193.583	<0.001	<0.001
Ball Realism*Look Type	3	0.051	0.017	1.601	**n.s.**	**n.s.**

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

For both the cup and ball models, the ANOVAs showed significant main effects of look type ($F(2,86)=42.11$ and $F(3,105)=193.58$ ps<.001 respectively*). Follow-up analysis revealed that the 'beginning' looks were greater than all other look types (Scheffe ps<.001).

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

MEMORY TASK

TABLE N.5 ANOVA SUMMARY TABLE FOR MEMORY RECALL SCORES

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	31	1.944	0.063		
Age	2	0.754	0.377	6.013	**<0.01**
Sex	1	0.001	0.001	0.018	n.s.
Presentation Order (Order)	1	0.240	0.240	3.831	n.s.
Age*Sex	2	0.208	0.104	1.656	n.s.
Age*Order	2	0.019	0.010	0.150	n.s.
Sex*Order	1	0.038	0.038	0.604	n.s.
Age*Sex*Order	2	0.024	0.012	0.190	n.s.
Error	31	0.991	0.032		
Display Type	1	0.231	0.231	7.240	**<0.05**
Age*Display Type	2	0.282	0.141	4.405	**<0.05**
Sex*Display Type	1	0.069	0.069	2.156	n.s.
Order*Display Type	1	0.201	0.201	6.275	**<0.05**
Age*Sex*Display Type	2	0.013	0.006	0.196	n.s.
Age*Order*Display Type	2	0.031	0.016	0.490	n.s.
Sex*Order*Display Type	1	0.039	0.039	1.212	n.s.
Age*Sex*Order*Display Type	2	0.019	0.010	0.304	n.s.

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

TABLE N.6 SUMMARY ANOVA TABLE FOR ARC CLUSTERING SCORES

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	25	23.254	0.930		
Age	2	0.362	0.181	0.195	n.s.
Presentation Order (Order)	1	0.054	0.054	0.058	n.s.
Age*Order	2	2.434	1.217	1.309	n.s.
Error	25	13.436	0.537		
Display Type	1	13.660	13.660	25.416	**<0.001**
Age*Display Type	2	0.735	0.368	0.684	**n.s.**
Order*Display Type	1	0.002	0.002	0.004	n.s.
Age*Order*Display Type	2	0.641	0.321	0.597	n.s.

n.s. = non-significant effect at p>0.05.
The main finding is highlighted.

TABLE N.7 **SUMMARY ANOVA TABLE FOR RECALL SCORES BY CLUSTERING CATEGORIES**

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	26	0.785	0.030		
Age	2	0.037	0.019	0.614	n.s.
Clustering - Mixed	2	0.129	0.065	2.138	**n.s.**
Age*Clustering	4	0.089	0.022	0.741	n.s.
Error	35	1.522	0.043		
Clustering - Grouped	2	0.455	0.227	5.231	**<0.05**

n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

SELECTIVE ATTENTION TASK

TABLE N.8 **ANOVA SUMMARY TABLE FOR TOTAL NUMBER OF ACCURATE JUDGEMENTS**

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	41	9.523	0.232		
Practice Order	1	0.626	0.626	2.694	n.s.
Error	31	6.345	0.205		
Experimental Order	3	0.248	0.083	0.403	n.s.
Age	2	1.792	0.896	4.378	**<0.05**
Age*Experimental Order	6	1.368	0.228	1.114	n.s.

n.s.= non-significant effect at p>0.05.
The main finding is highlighted.

APPENDIX O

Summary ANOVA tables, details of subsidiary findings and frequency data for the Friedman tests, for the Longitudinal phase analysis (Chapter 11).

DRAWING TASK

TABLE O.1 SUMMARY ANOVA TABLE FOR NUMBER OF LOOKS

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	40	1.450	0.036			
Cohort	2	0.437	0.219	6.032	**<0.01**	
Error	80	1.466	0.018			
Phase	2	0.083	0.041	2.264	**n.s.**	
Cohort*Phase	4	0.225	0.563	3.072	**<0.05**	**<0.05**
Error	40	0.610	0.015			
Drawing Model	1	0.697	0.070	4.569	<0.05	
Cohort*Model	2	0.009	0.004	0.285	n.s.	
Error	120	2.456	0.020			
Look Type	3	20.986	6.995	341.802	<0.001	<0.001
Cohort*Look Type	6	0.248	0.041	2.023	n.s.	n.s.
Error	80	0.827	0.010			
Phase*Model	2	0.022	0.011	1.073	n.s.	n.s.
Cohort*Phase*Model	4	0.209	0.052	5.056	<0.01	<0.01
Error	240	4.038	0.017			
Phase*Look Type	6	0.106	0.018	1.048	n.s.	n.s.
Cohort*Phase*Look Type	12	0.460	0.038	2.279	<0.01	<0.01
Error	120	1.938	0.016			
Model*Look Type	3	0.432	0.144	8.914	<0.001	<0.001
Cohort*Model*Look Type	6	0.402	0.067	4.148	<0.01	<0.01
Error	240	3.113	0.013			
Phase*Model*Look Type	6	0.094	0.016	1.209	n.s.	n.s.
Cohort*Phase*Model *Look Type	12	0.416	0.035	2.673	**<0.01**	**<0.01**

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The ANOVA showed a significant main effect of drawing model ($F(1,40)=4.57$ $p<.05$) and look type ($F(3,110)=341.80$ $p<.001$*). The children paid more attention to the cup model than the ball model, and more looking occurred at the 'beginning' of the task compared to all other look types (Scheffe ps<.001), and the 'within' looks were greater

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

than the 'between' and 'end' look types (Scheffe ps<.05). The interaction between drawing model and look type (F(3,107)=8.91 p<.001*) showed that although the cup model showed the same pattern of results as the main effect of look type, the ball model only showed the 'beginning' looks being significantly greater than the other three look types (Scheffe ps<.001). The interaction between cohort, drawing model and look type (F(5,107)=4.15 p<.01*) showed that this high level of 'within' looking for the cup model was only evident for cohort 3.

There was a significant interaction between cohort, phase and drawing model (F(4,79)= 5.06 p<.01*), however there were no significant differences between the means at follow-up. The significant interaction between cohort, phase and look type (F(9,183)= 2.28 p<.01*) showed that the 'beginning' looks were greater than all other look types for all combinations of cohort and phase, except for cohort 1 at Phase 3 who showed no significant differences between any of the four look types.

TABLE O.2 SUMMARY ANOVA TABLE FOR BETWEEN COHORT ANALYSIS FOR NUMBER OF LOOKS MEASURE

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	27	0.529	0.020			
Cohort (1 and 2)	1	0.000	0.000	0.001	**n.s.**	
Error	27	0.603	0.022			
Model	1	0.189	0.189	8.474	<0.01	
Cohort(1/2)*Model	1	0.219	0.219	0.982	n.s.	
Error	81	1.571	0.019			
Look Type (L.T.)	3	4.362	1.454	74.966	<0.001	<0.001
Cohort(1/2)*Look Type	3	0.076	0.025	1.306	n.s.	n.s.
Error	81	1.576	0.019			
Model*Look Type	3	0.125	0.042	2.145	n.s.	n.s.
Cohort(1/2)*Model*L.T.	3	0.067	0.022	1.145	n.s.	n.s.
Error	29	0.673	0.023			
Cohort (2 and 3)	1	0.009	0.009	0.380	**n.s.**	
Error	29	0.297	0.010			
Model	1	0.015	0.015	1.415	n.s.	
Cohort(2/3)*Model	1	0.004	0.004	0.418	n.s.	
Error	87	1.648	0.019			
Look Type (L.T.)	3	4.781	1.594	84.113	<0.001	<0.001
Cohort(2/3)*Look Type	3	0.123	0.041	2.171	n.s.	n.s.
Error	87	1.111	0.013			
Model*Look Type	3	0.032	0.011	0.831	n.s.	n.s.
Cohort(2/3)*Model*L.T.	3	0.039	0.013	1.008	n.s.	n.s.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

Subsidiary Findings

For the ANOVA comparing cohorts 1 and 2, there was a significant main effect of model ($F(1,27)=8.47$ $p<.01$) in that more attention was paid to the cup model than the ball model. For both ANOVAs there were significant main effects of look type (ps<.001), in that the 'beginning' looks were greater than all other look types.

TABLE O.3 SUMMARY ANOVA TABLE FOR LOOKING TIME

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	40	1.421	0.036			
Cohort	2	0.551	0.275	7.750	**<0.01**	
Error	80	1.485	0.019			
Phase	2	0.012	0.006	0.337	**n.s.**	
Cohort*Phase	4	0.388	0.097	5.222	**<0.01**	**<0.01**
Error	40	0.681	0.017			
Drawing Model	1	0.007	0.007	0.437	n.s.	
Cohort*Model	2	0.024	0.012	0.712	n.s.	
Error	120	2.594	0.022			
Look Type	3	48.115	16.038	742.014	<0.001	<0.001
Cohort*Look Type	6	0.154	0.026	1.187	n.s.	n.s.
Error	80	0.980	0.012			
Phase*Model	2	0.066	0.033	2.684	n.s.	n.s.
Cohort*Phase*Model	4	0.231	0.058	4.711	<0.01	<0.01
Error	240	3.991	0.017			
Phase*Look Type	6	0.230	0.038	2.300	<0.05	<0.05
Cohort*Phase*Look Type	12	0.295	0.025	1.479	n.s.	n.s.
Error	120	1.717	0.014			
Model*Look Type	3	0.624	0.208	14.549	<0.001	<0.001
Cohort*Model*Look Type	6	0.358	0.060	4.175	<0.01	<0.01
Error	240	3.130	0.013			
Phase*Model*Look Type	6	0.080	0.013	1.018	n.s.	n.s.
Cohort*Phase*Model *Look Type	12	0.233	0.019	1.486	n.s.	n.s.

† Epsilon corrected (Greenhouse-Geiser) probability values.
n.s. = non-significant effect at p>0.05.
The main findings are highlighted.

Subsidiary Findings

The ANOVA showed a highly significant main effect look type ($F(3,107)=742.01$ $p<.001$*), in that more looking occurred at the 'beginning' of the task compared to all other look types (Scheffe ps<.001), and the 'within' looks were greater than the 'between' and 'end' look types (Scheffe ps<.05). The interaction between drawing model and look

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

type (F(3,107)=14.55 p<.001*) showed that although the cup model showed the same pattern of results as the main effect of look type, the ball model only showed the 'beginning' looks being significantly greater than the other three look types (Scheffe ps<.001). The interaction between cohort, drawing model and look type (F(5,107)=4.18 p<.01*) showed that the 'beginning' looks were greater than all other look types for all combinations of cohort and drawing model (Scheffe ps<.001).

There was a significant interaction between cohort, phase and drawing model (F(4,79)= 4.71 p<.01*), however there were no significant differences between the means at follow-up. The significant interaction between phase and look type (F(5,193)=2.30 p<.05*) showed that the 'beginning' looks were greater than all other look types for each phase (Scheffe ps<.001).

TABLE O.4 **SUMMARY ANOVA TABLE FOR BETWEEN COHORT ANALYSIS FOR LOOKING TIME MEASURE**

SOURCE	D.F.	S.S.	M.S.	F.	P.	G-G P.†
Error	27	0.512	0.019			
Cohort (1 and 2)	1	0.002	0.002	0.124	**n.s.**	
Error	27	0.689	0.026			
Model	1	0.204	0.204	8.012	<0.01	
Cohort(1/2)*Model	1	0.013	0.013	0.525	n.s.	
Error	81	1.753	0.022			
Look Type (L.T.)	3	9.508	3.169	146.427	<0.001	<0.001
Cohort(1/2)*Look Type	3	0.062	0.021	0.951	n.s.	n.s.
Error	81	1.384	0.017			
Model*Look Type	3	0.105	0.035	2.053	n.s.	n.s.
Cohort(1/2)*Model*L.T.	3	0.045	0.015	0.885	n.s.	n.s.
Error	29	0.566	0.020			
Cohort (2 and 3)	1	0.048	6.515	2.436	**n.s.**	
Error	29	0.297	0.010			
Model	1	0.041	0.041	4.008	n.s.	
Cohort(2/3)*Model	1	0.030	0.030	2.958	n.s.	
Error	87	1.351	0.016			
Look Type (L.T.)	3	9.913	3.304	212.785	<0.001	<0.001
Cohort(2/3)*Look Type	3	0.100	0.033	2.138	n.s.	n.s.
Error	87	0.980	0.011			
Model*Look Type	3	0.056	0.019	1.667	n.s.	n.s.
Cohort(2/3)*Model*L.T.	3	0.012	0.004	0.347	n.s.	n.s.

* Epsilon corrected (Greenhouse-Geiser) degrees of freedom and probability values.

Subsidiary Findings

For the ANOVA comparing cohorts 1 and 2, there was a significant main effect of model ($F(1,27)=8.01$ $p<.01$) in that more attention was paid to the cup model than the ball model. For both ANOVAs there were significant main effects of look type ($ps<.001$), in that the 'beginning' looks were greater than all other look types.

TABLE O.5 **FREQUENCY DATA FOR STRATEGIC ATTENTION CATEGORIES (FRIEDMAN ANALYSIS)**

COHORT	PHASE	BALL MODEL *			CUP MODEL *		
		N.S.	L.S.	E.S.	N.S.	L.S.	E.S.
1	1	8	2	2	4	4	4
	2	6	4	2	7	4	1
	3	6	4	2	5	2	5
2	1	5	9	3	5	3	9
	2	9	6	2	13	2	2
	3	9	4	4	9	3	5
3	1	4	2	8	6	4	4
	2	6	2	6	2	2	10
	3	5	2	7	4	2	8

* N.S. = Non-Strategic
L.S. = Limited Strategic
E.S. = Extensively Strategic

TABLE O.6 **FREQUENCY DATA FOR META-AWARENESS CATEGORIES (FRIEDMAN ANALYSIS)**

COHORT	PHASE	BALL MODEL *			CUP MODEL *		
		N.A.	L.A.	E.A.	N.A.	L.A.	E.A.
1	1	7	5	0	6	6	0
	2	5	7	0	5	7	0
	3	2	10	0	3	9	0
2	1	6	9	2	7	6	4
	2	6	11	0	3	13	1
	3	1	14	2	2	13	2
3	1	3	6	5	4	5	5
	2	3	6	5	3	8	3
	3	1	12	1	3	10	1

* N.A. = No Awareness
L.A. = Limited Awareness
E.A. = Extensive Awareness

MEMORY TASK

TABLE O.7 SUMMARY ANOVA TABLE FOR BETWEEN COHORT ANALYSIS FOR MEMORY RECALL SCORES

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	27	211.988	7.851		
Cohort (1 and 2)	1	2.530	2.529	0.322	**n.s.**
Error	27	100.066	3.706		
Display Type	1	6.865	6.865	1.852	n.s.
Cohort(1/2)*Display Type	1	0.037	0.037	0.010	n.s.
Error	29	157.655	5.436		
Cohort (2 and 3)	1	36.312	36.312	6.679	**<0.05**
Error	29	66.471	2.292		
Display Type	1	14.465	14.465	6.311	**<0.05**
Cohort(2/3)*Display Type	1	16.271	16.271	7.099	**<0.05**

Subsidiary Findings

For the ANOVA comparing cohorts 2 and 3, there was a significant main effect of display type ($F(1,29)=6.31$ $p<.05$) in that the grouped display type led to increased recall.

TABLE O.8 SUMMARY ANOVA TABLE FOR BETWEEN COHORT ANALYSIS FOR ARC CLUSTERING SCORES

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	14	19.354	1.382		
Cohort (1 and 2)	1	0.063	0.063	0.046	**n.s.**
Error	14	7.481	0.534		
Display Type	1	4.500	4.500	8.423	<0.05
Cohort(1/2)*Display Type	1	0.395	0.395	0.738	n.s.
Error	24	25.157	1.048		
Cohort (2 and 3)	1	0.141	0.141	0.134	**n.s.**
Error	24	8.472	0.355		
Display Type	1	12.004	12.004	34.008	<0.001
Cohort(2/3)*Display Type	1	0.913	0.913	2.586	n.s.

Subsidiary Findings

For both ANOVAs there was a significant main effect of display type (ps<.05) in that the grouped display type led to more cards being recalled.

TABLE O.9 **FREQUENCY DATA FOR STRATEGIC CLUSTERING CATEGORIES (FRIEDMAN ANALYSIS)**

COHORT	PHASE	MIXED DISPLAY TYPE *				GROUPED DISPLAY TYPE *			
		UD.	N.S.	L.S.	E.S	UD.	N.S.	L.S.	E.S
1	1	7	3	2	0	6	3	0	2
	2	4	4	2	2	3	0	3	6
	3	2	5	1	4	3	1	3	5
2	1	5	7	3	3	5	2	2	8
	2	5	5	4	2	3	4	4	6
	3	4	6	5	3	2	3	4	8
3	1	0	6	7	1	0	1	3	10
	2	1	8	2	3	0	0	5	9
	3	2	7	3	2	0	0	0	14

* UD. = Undefined
N.S. = Non-Strategic
L.S. = Limited Strategic
E.S. = Extensively Strategic

TABLE O.10 **FREQUENCY DATA FOR META-AWARENESS CATEGORIES (FRIEDMAN ANALYSIS)**

COHORT	PHASE	META-AWARENESS CATEGORY		
		NON	LIMITED	EXTENSIVE
1	1	12	0	0
	2	11	1	0
	3	8	3	1
2	1	9	7	1
	2	7	4	6
	3	9	2	6
3	1	4	3	7
	2	3	1	6
	3	2	2	10

SELECTIVE ATTENTION TASK

TABLE O.11 **SUMMARY ANOVA TABLE FOR BETWEEN COHORT ANALYSIS FOR TOTAL NUMBER OF ACCURATE JUDGEMENTS**

SOURCE	D.F.	S.S.	M.S.	F.	P.
Error	27	29.137	1.079		
Cohort (1 and 2)	1	0.173	0.173	0.160	n.s.
Error	29	19.479	0.672		
Cohort (2 and 3)	1	0.005	0.005	0.007	n.s.

TABLE O.12 FREQUENCY DATA FOR STRATEGIC WINDOW OPENING CATEGORIES (FRIEDMAN ANALYSIS)

COHORT	PHASE	STRATEGIC CATEGORY		
		NON	LIMITED	EXHAUSTIVE
1	1	5	7	0
	2	2	10	0
	3	2	8	2
2	1	1	6	10
	2	4	5	8
	3	0	6	11
3	1	2	4	8
	2	1	3	10
	3	0	2	12

TABLE O.13 FREQUENCY DATA FOR META-AWARENESS CATEGORIES (FRIEDMAN ANALYSIS)

COHORT	PHASE	META-AWARENESS CATEGORY		
		NON	LIMITED	EXTENSIVE
1	1	9	3	0
	2	6	2	4
	3	3	2	7
2	1	2	7	8
	2	2	5	10
	3	1	2	14
3	1	1	1	12
	2	0	0	14
	3	0	1	13

APPENDIX P

LIST OF PARTICIPATING PLYMOUTH SCHOOLS

Barne Barton Primary School.

Bull Point Primary School.

Highfield Infants School.

Highfield Junior Mixed School.

Langley Infants School.

Langley Junior School.

Plaistow Hill Infants School.

Southway Infants School.

Southway Junior Mixed School.

Western Mill County Primary School.

REFERENCES

Arrowsmith C.J., Cox M.V. & Eames K. (1994). Eliciting partial occlusions in the drawings of four- and five-year-olds. British Journal of Developmental Psychology, Vol. **12**, 577-584.

Baker-Ward L., Ornstein P.A., & Holden D.J. (1984). The expression of memorization in early childhood. Journal of Experimental Child Psychology, Vol. **37**, 555-575.

Barrett M., Beaumont A.V. & Jennett M.S. (1985). Some children do sometimes do what they have been told to do: task demands and verbal instructions in children's drawings. In N.H. Freeman & M.V. Cox (Eds.) Visual Order: The Nature and Development of Pictorial Representation. London: Cambridge University Press.

Barrett M. & Bridson A. (1983). The effect of instructions upon children's drawings. British Journal of Developmental Psychology, Vol. **1(2)**, 175-178.

Barrett M., Sutherland A. & Lee F. (1987). Visual realism in children's drawings: the effect of instructions. Paper presented at the British Psychological Society Developmental Section Annual Conference, York, September 1987.

Beal C.R. & Arnold D.S. (1990) The effect of instructions on view-specificity in young children's drawing and picture selection. British Journal of Developmental Psychology, Vol. **8**, 393-400.

Bremner J.G. & Batten A. (1991). Sensitivity to viewpoint in children's drawings of objects and relations between objects. Journal of Experimental Child Psychology, Vol. **52**, 375-394.

Bremner J.G. & Moore S. (1984). Prior visual inspection and object naming: Two factors that enhance hidden feature inclusion in young children's drawings. British Journal of Developmental Psychology, Vol. **2(4)**, 371-376.

Chen M.J. & Holman J. (1989). Emergence of drawing devices for total and partial occlusion: a longitudinal study. Perception, Vol. **18**, 445-455.

Clark A.B. (1897). The child's attitude towards perspective problems. In E. Barnes (Ed.) Studies in Education. Vol. **1**. Standford, California: Standford University Press. Cited in Cox M.V. (1985).

Cox M.V. (1981). Spatial depth relationships in young children's drawings. Educational Psychology, Vol. **1**, 275-287.

Cox M.V. (1985). One object behind another: young children's use of array-specific and view-specific representations. In N.H. Freeman & M.V. Cox (Eds.) Visual Order: The Nature and Development of Pictorial Representation. London: Cambridge University Press.

Cox M.V. (1986). Cubes are difficult things to draw. British Journal of Developmental Psychology, Vol. **4(4)**, 341-345.

Cox M.V. (1991). The Child's Point of View. London: Harvester Wheatsheaf.

Cox M.V. & Martin A. (1988). Young children's viewer-centred representations: drawings of a cup placed inside or behind a transparent or opaque beaker. International Journal of Behavioural Development, Vol. **11**, 233-245.

Cunningham J.G. & Weaver S.L. (1989). Young children's knowledge of their memory span: Effects of task and experience. Journal of Experimental Child Psychology, Vol. **48**, 32-44.

Daehler M.W. & Butatko D. (1985). Cognitive Development. New York: Alfred A. Knopf.

Davis A.M. (1983). Contextual sensitivity in young children's drawings. Journal of Experimental Child Psychology, Vol. **35**, 478-486.

Davis A.M. & Bentley M. (1984). Young children's interpretation of the task demands in a simple experimental situation: an example from drawing. Educational Psychology, Vol. **4(3)**, 249-254.

Day M.C. & Bissell J.S. (1978). Criteria for same and differenct judgements and visual comparison strategies of four-year-olds. Child Development, Vol. **49**, 353-361.

DeMarie-Dreblow D. & Miller P.H. (1988). The development of children's strategies for selective attention: Evidence for a transitional period. Child Development, Vol. **59**, 1504-1513.

Flavell J.H., Friedrichs A.G. & Hoyt J.D. (1970). Developmental changes in memorization processes. Cognitive Psychology, Vol. **1**, 324-340.

Freeman N.H. (1977). How young children try to plan drawings. In G.E. Butterworth (Ed.) The Child's Representation of the World. New York: Plenum Press.

Freeman N.H. (1980). Strategies of Representation in Young Children. London: Academic Press.

Freeman N.H. & Janikoun (1972). Intellectual realism in children's drawings of a familiar object with distinctive features. Child Development, Vol. **43**, 1116-1121.

Goodenough F.L. (1926). Measurement of Intelligence by Drawings. New York: Harcourt, Bruce & World.

Harris D.B. (1963). Children's Drawings as Measures of Intellectual Maturity. New York: Harcourt, Bruce & World.

Henry L.A. & Norman T. (in press). The relationships between memory performance, use of simple memory strategies and metamemory in young children.

Howell D.D. (1987). Statistical Methods in Psychology. Second Edition. Boston: Duxbury Press.

Howell D.D. (1992). Statistical Methods in Psychology. Third Edition. California: Duxbury Press.

Kail R. (1990). The Development of Memory in Children. Third Edition. New York: Freeman.

Kee D.W. & Bell T.S. (1981). The development of organizational strategies in the storage and retrieval of categorical items in free-recall learning. Child Development, Vol. **52**, 1163-1171.

Kennedy J.J. (1983). Analysing Qualitative Data: Introductory Log-Linear Analysis for Behavioural Research. New York: Praeger.

Klaue K. (1992). The development of depth representaion in children's drawings: Effects of graphic surface and visibility of the model. British Journal of Developmental Psychology, Vol. **10**, 71-83.

Kobasigawa A. (1974). Utilization of retrieval cues by children in recall. Child Development, Vol. **45**, 127-134.

Lewis C., Russell C. & Berridge D. (1993). When is a mug not a mug? Effects of content, naming, and instructions on children's drawings. Journal of Experimental Child Psychology, Vol. **56**, 291-302.

Light P. (1985). The development of view-specific representation considered from a socio-cognitive standpoint. In N.H. Freeman & M.V. Cox (Eds.) Visual Order: The Nature and Development of Pictorial Representation. London: Cambridge University Press.

Light P. & Humphreys J. (1981). Internal spatial relations in young children's drawings. Journal of Experimental Child Psychology, Vol. **31**, 521-530.

Light P. & Simmons B. (1983). The effect of a communication task upon the representation of the depth relationships in young children's drawings. Journal of Experimental Child Psychology, Vol. **35**, 81-89.

Luquet G.H. (1913). Le Dessins d'un Enfant. Paris: Alcan. Cited in Cox M.V. (1991).

Luquet G.H. (1927). Le Dessin Enfantin. Paris: Alcan. Cited in Cox M.V. (1991).

Miller P.H. & Weiss M.G. (1981). Children's attention allocation, understanding of attention, and performance on the incidental learning task. Child Development, Vol. **52**, 1183-1190.

Mitchelmore M.C. (1978). Developmental stages in children's representation of regular solid figures. Journal of Genetic Psychology, Vol. **133(2)**, 229-239.

Moely B.E., Olson F.A., Halwes T.G. & Flavell J.H. (1969). Production deficiency in young children's clustered recall. Developmental Psychology, Vol. **1(1)**, 26-34.

Murphy M.D. (1979). Measurement of categorical clustering in free recall. In C.R. Puff (Ed.) Memory, Organiziation and Structure. New York: Academic Press.

Murphy M.D. & Puff C.R. (1982). Free recall: Basic methodology and analysis. In C.R. Puff (Ed.) Handbook of Research Methods in Human Memory and Cognition. New York: Academic Press.

Nieland M. & Cox M.V. Reported in Cox M.V. (1991). The Child's Point of View. London: Harvester Wheatsheaf.

Roenker D.L., Thompson C.P. & Brown S.C. (1971). Comparison measures for the estimation of clustering in free recall. Psychological Bulletin, Vol. **76(1)**, 45-48.

Schneider W. & Sodian B. (1988). Metamemory-memory behaviour relationships in young children: Evidence from a memory-for-location task. Journal of Experimental Child Psychology, Vol. **45**, 209-233.

Schneider W. & Sodian B. (1991). A longitudinal study of young children's memory behaviour and performance in a sort-recall task. Journal of Experimental Child Psychology, Vol. **51**, 14-29.

Siegel S. (1956). Non-Parametric Statistics for the Behavioural Sciences. New York: McGaw Hill.

Siegel S. & Castellan N. J. Jr. (1988). Non-Parametric Statistics for the Behavioural Sciences. Second Edition. New York: McGaw Hill.

Smith L. & Campbell J. (1987). One thing behind another: A school based study of children's drawing ability. Educational Psychology, Vol. **7(4)**, 283-293.

Sodian B., Schneider W. & Perlmutter M. (1986). Recall, clustering and metamemory in young children. Journal of Experimental Child Psychology, Vol. **41**, 395-410.

Taylor M. & Bacharach V.R. (1982). Constraints on the visual accuracy of drawings produced by young children. Journal of Experimental Child Psychology, Vol. **34**, 311-329.

Thomas G.V. & Silk A.M.J. (1990). An Introduction to the Psychology of Children's Drawings. London: Harvester Wheatsheaf.

Vurpillot E. (1968). The development of scanning strategies and their relation to visual differentiation. Journal of Experimental Child Psychology, Vol. **6**, 632-650.